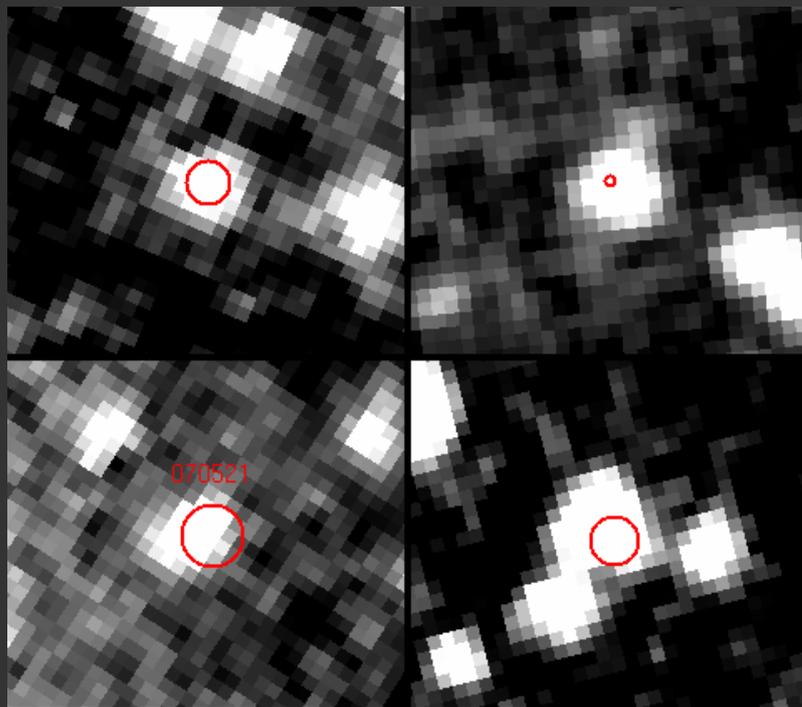


Near and mid-infrared observations of dark GRB hosts:

Evidence for a dusty, massive, high-metallicity subpopulation

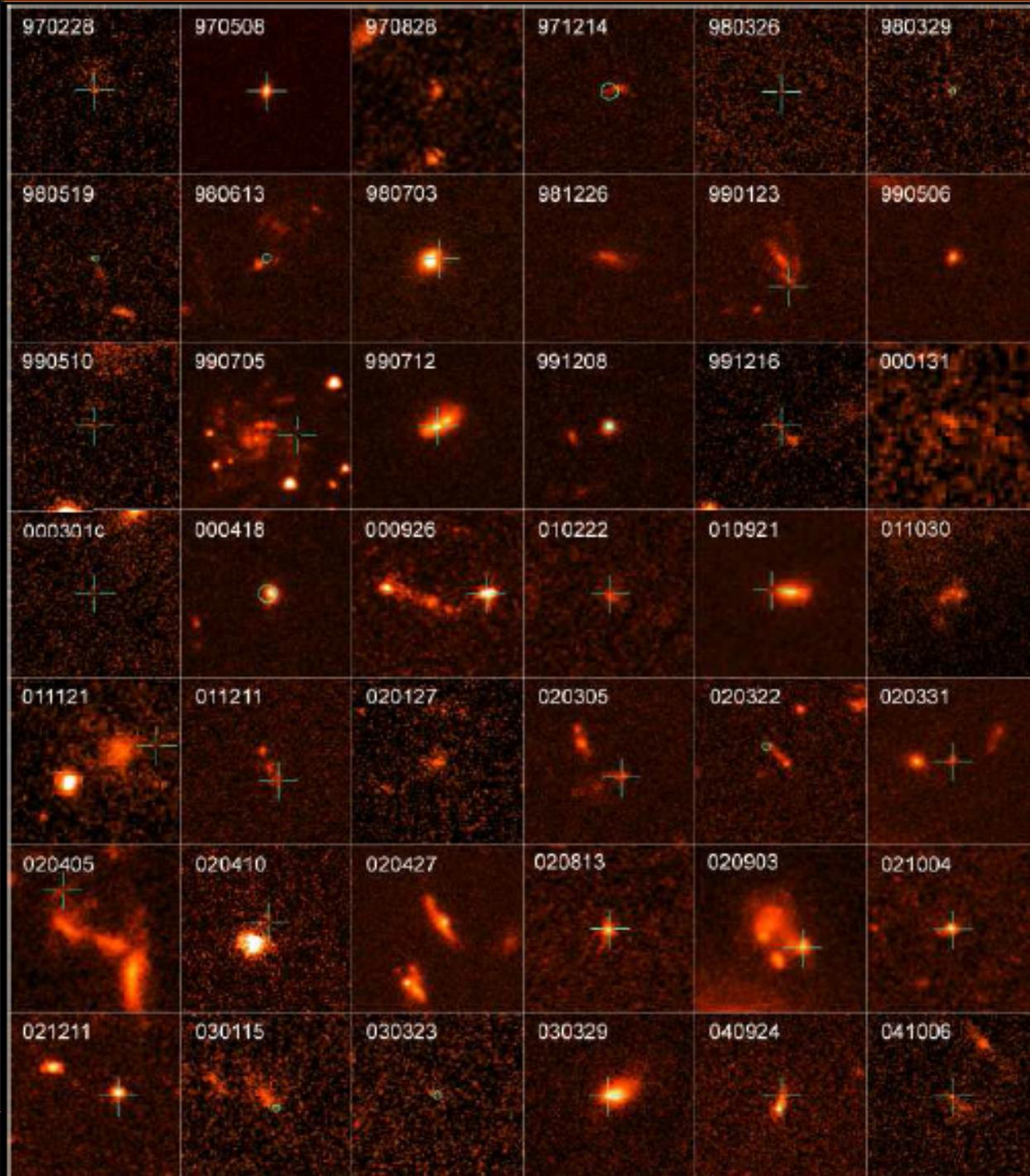
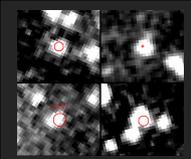


Daniel Perley (UC Berkeley)

+ *Joshua Bloom, Andrew Levan, Nial Tanvir,
Brad Cenko, Jens Hjorth, Daniele Malesani,
Johan Fynbo, Hsiao-Wen Chen*

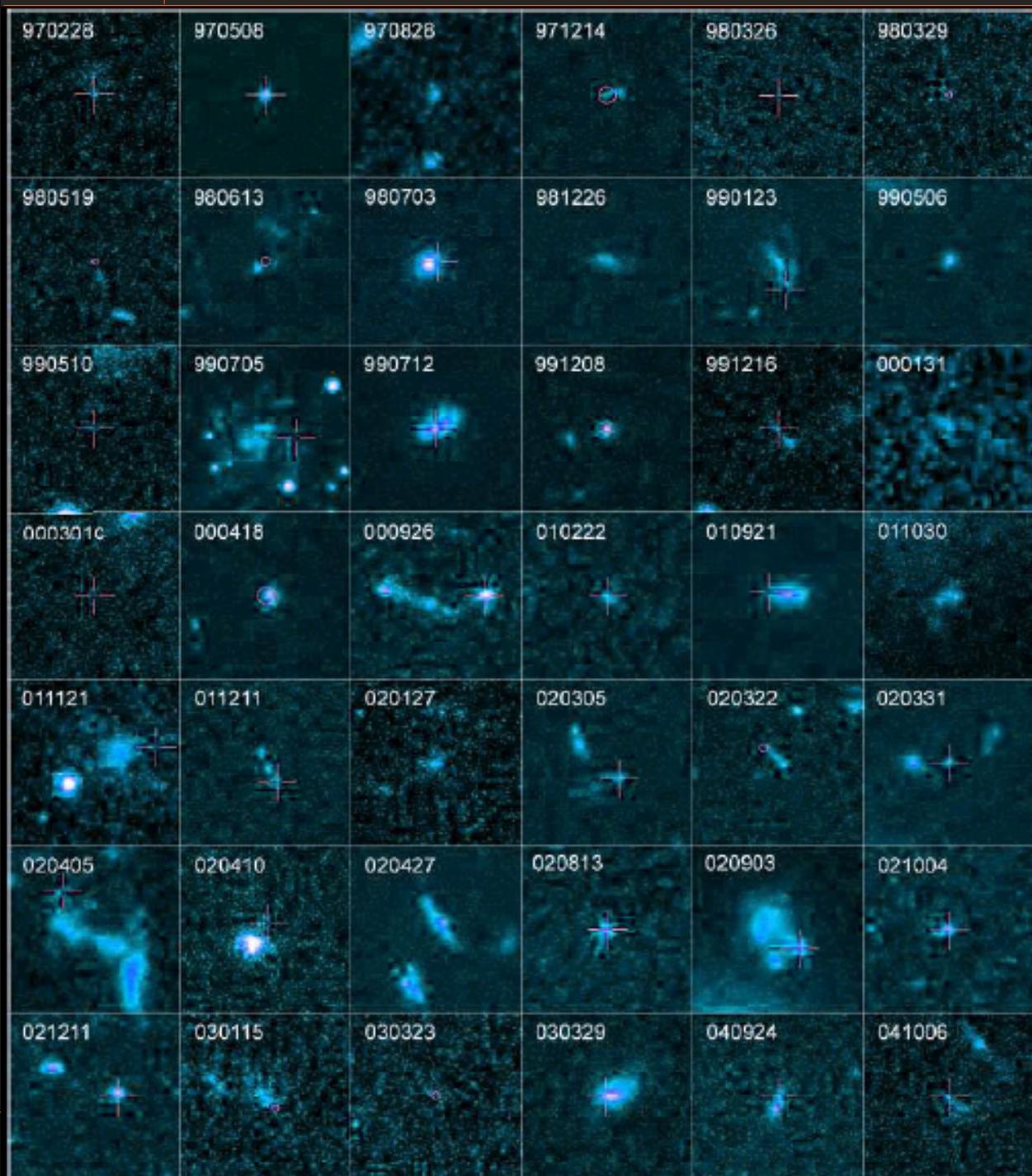
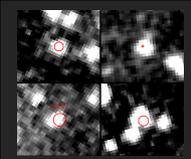
2010 November 4
Annapolis, Maryland

Pre-Swift Host Galaxies



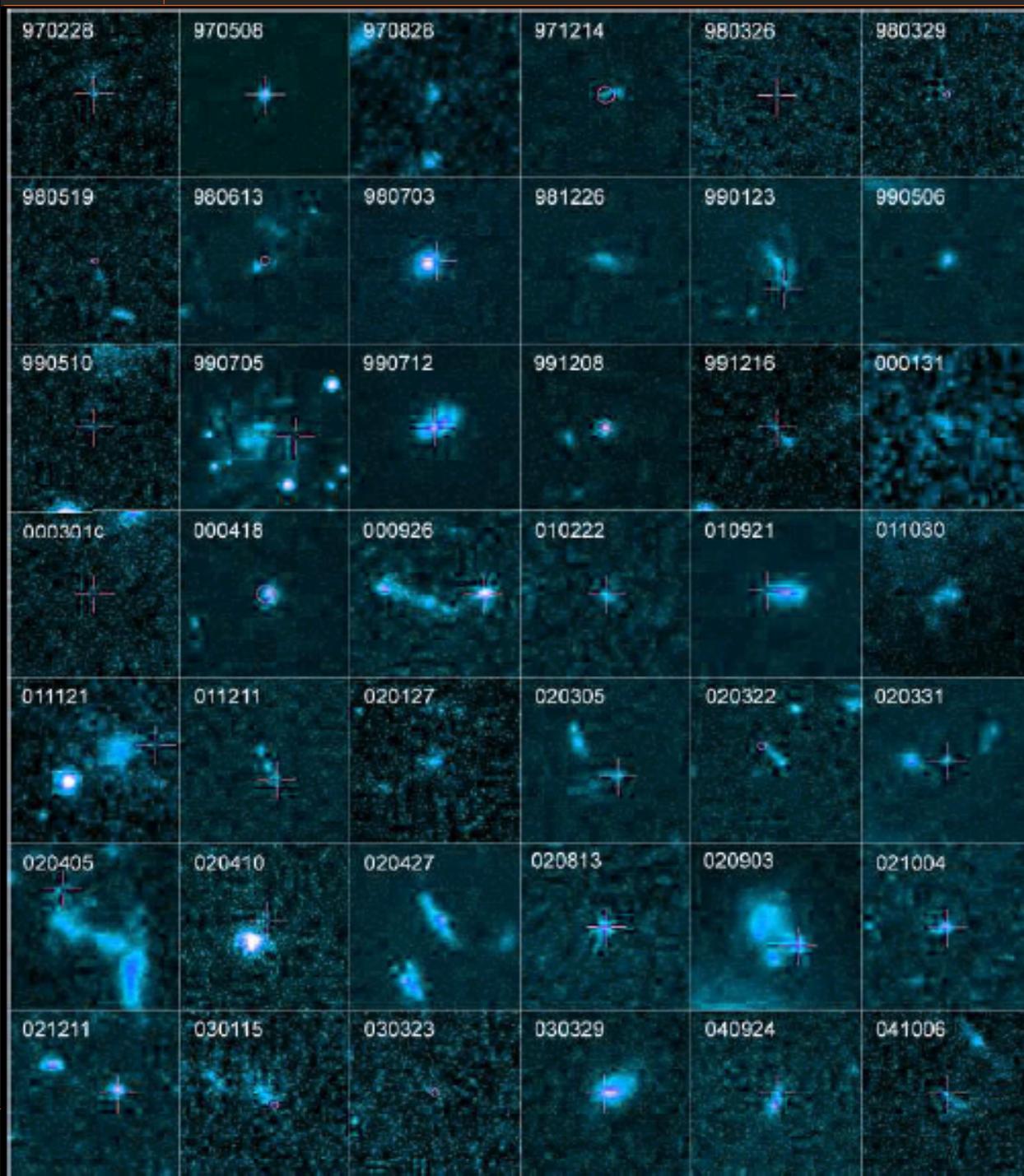
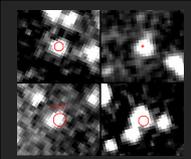
Fruchter et al. 2006

Pre-Swift Host Galaxies



Fruchter et al. 2006

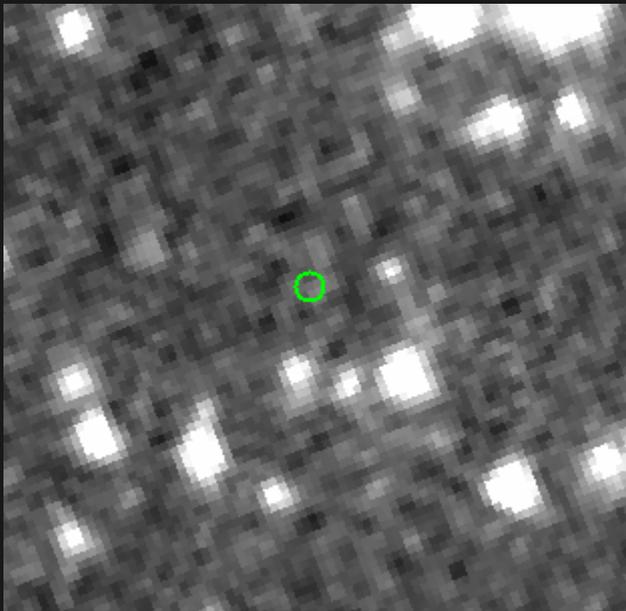
Pre-Swift Host Galaxies



Blue galaxies:

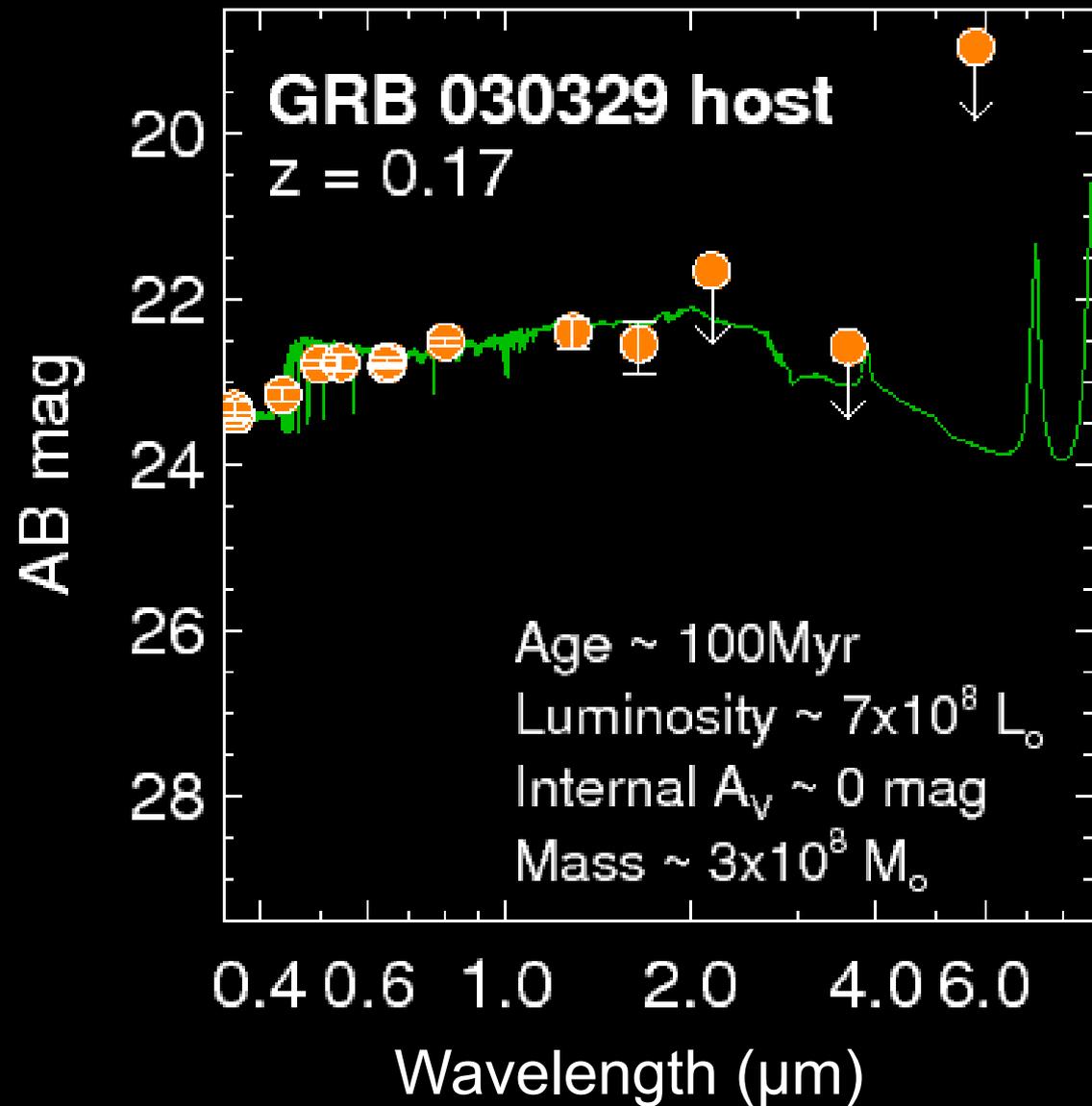
rapidly star-forming
unobscured

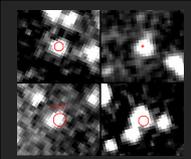
Fruchter et al. 2006



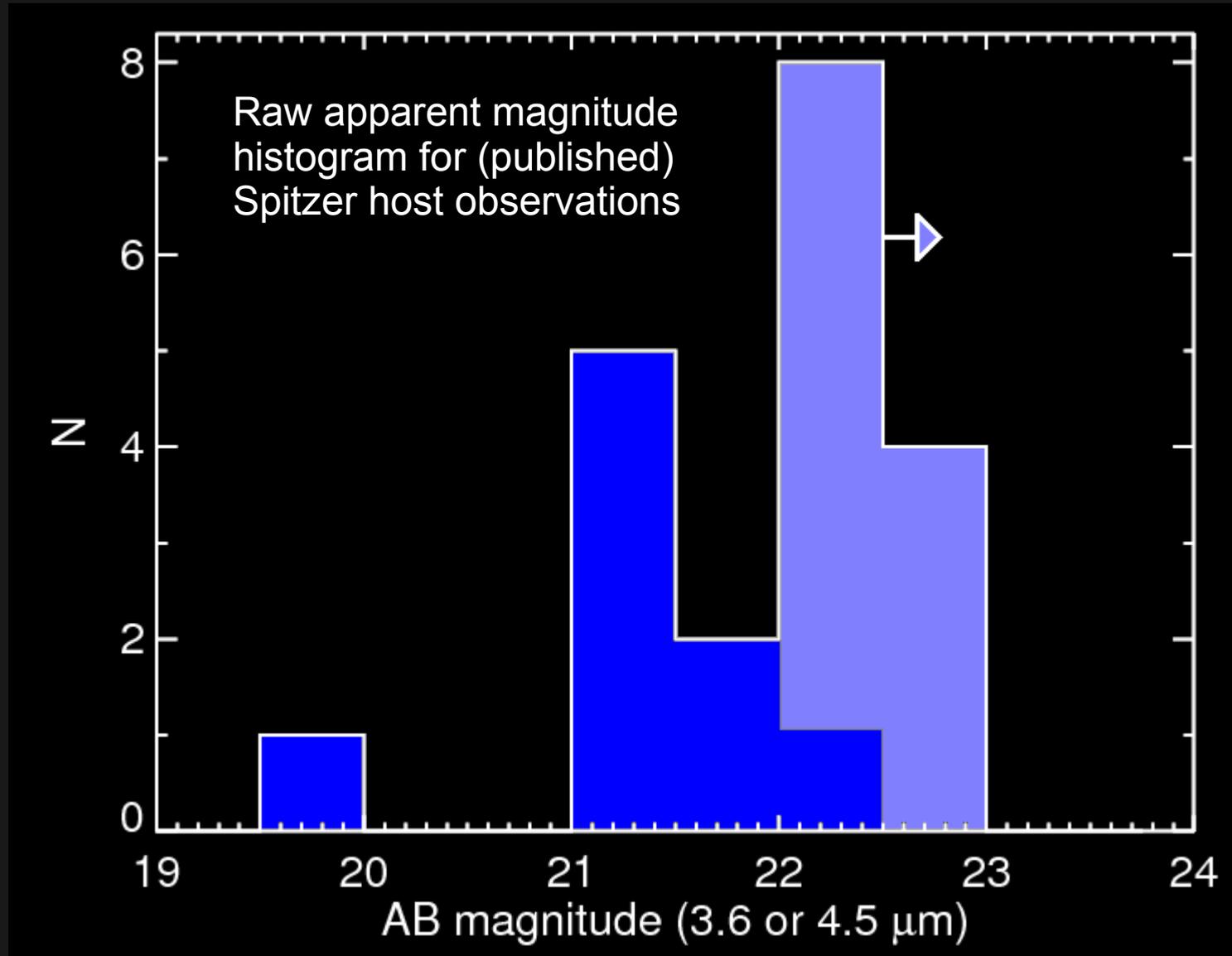
Host of GRB 030329
at $z = 0.17$:

No detection at
2.2 μm , 3.6 μm ,
5.8 μm ...

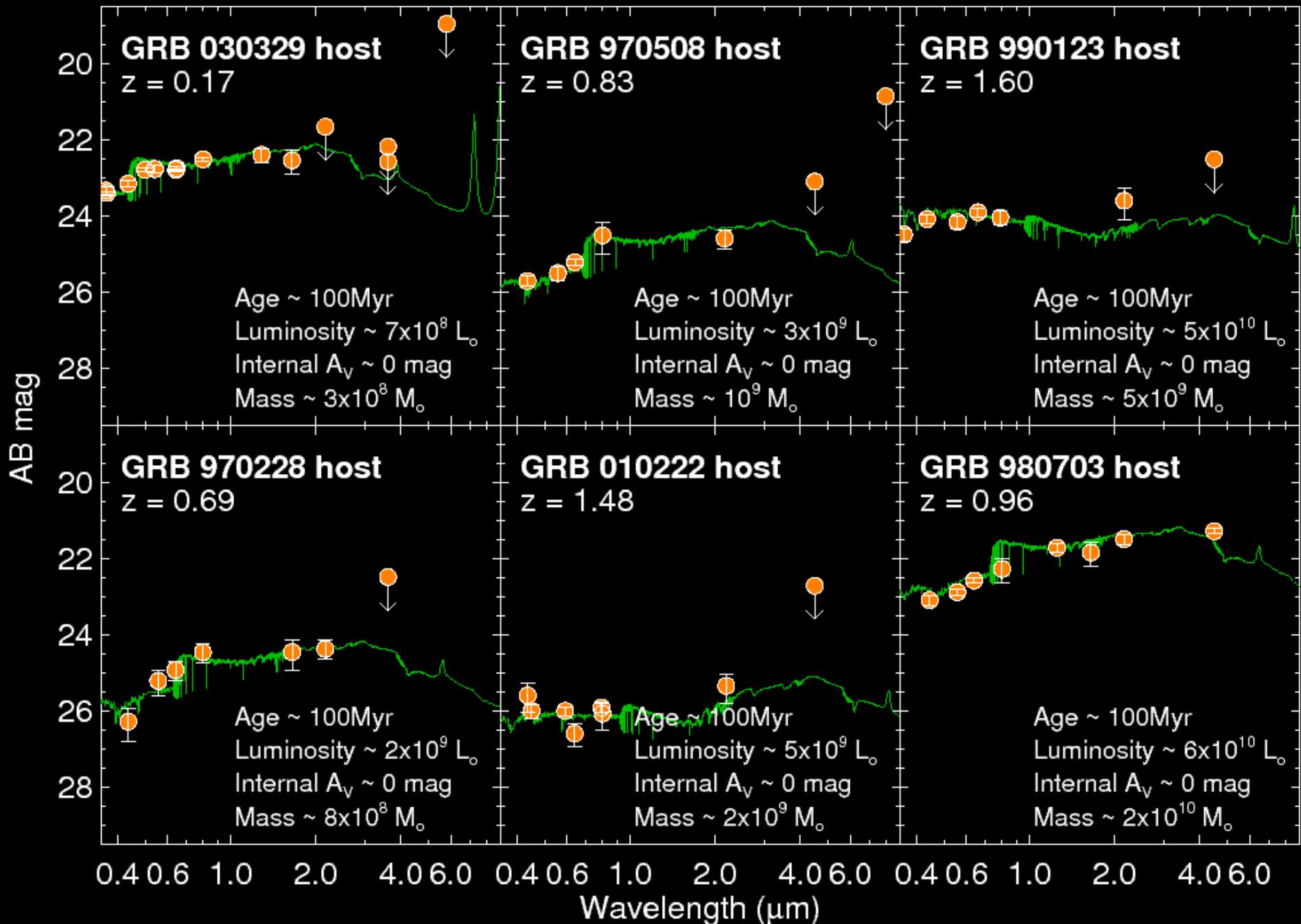




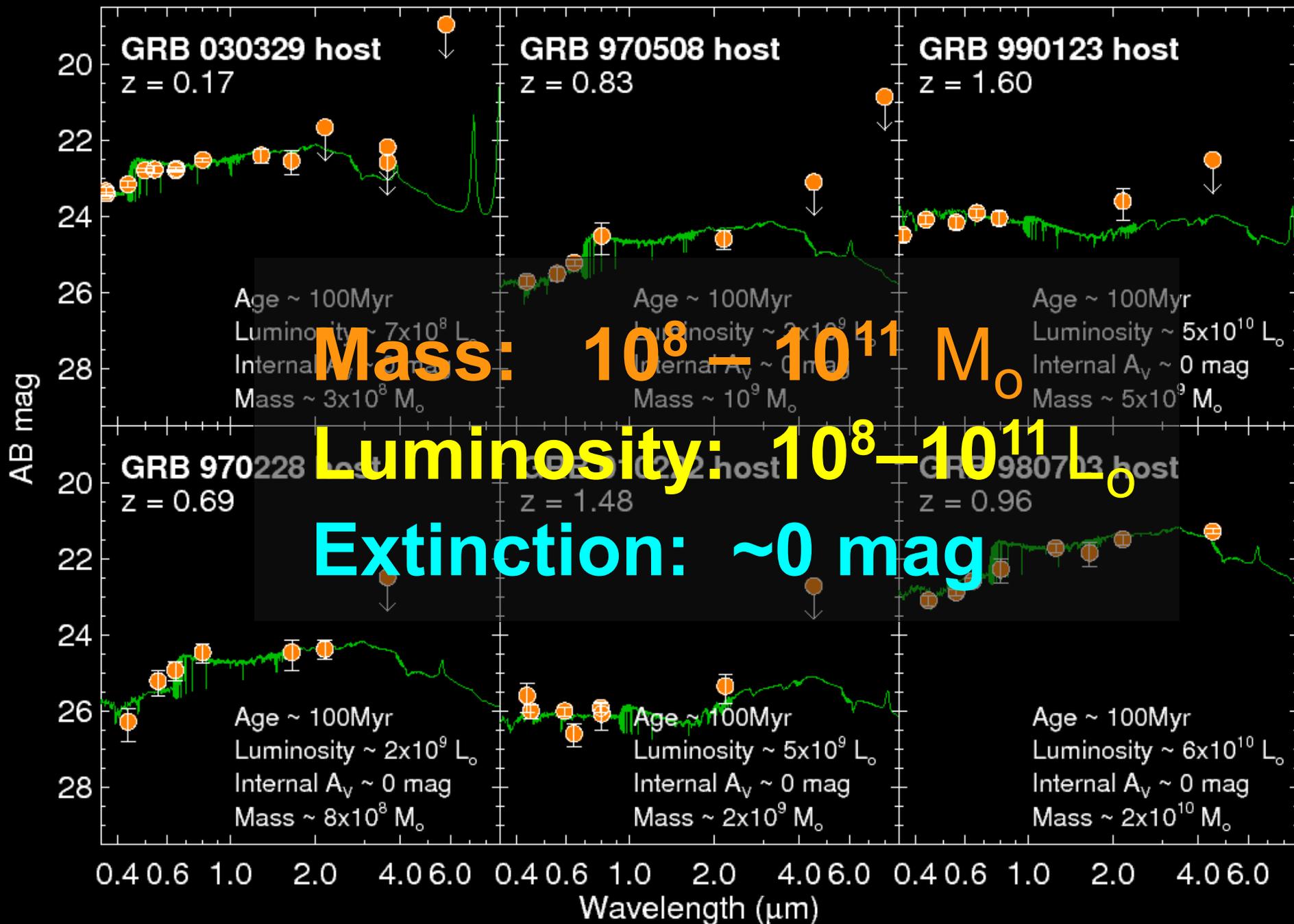
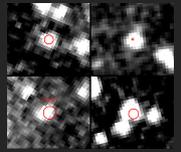
Pre-Swift Spitzer (non)detections



Ordinary GRB host SEDs

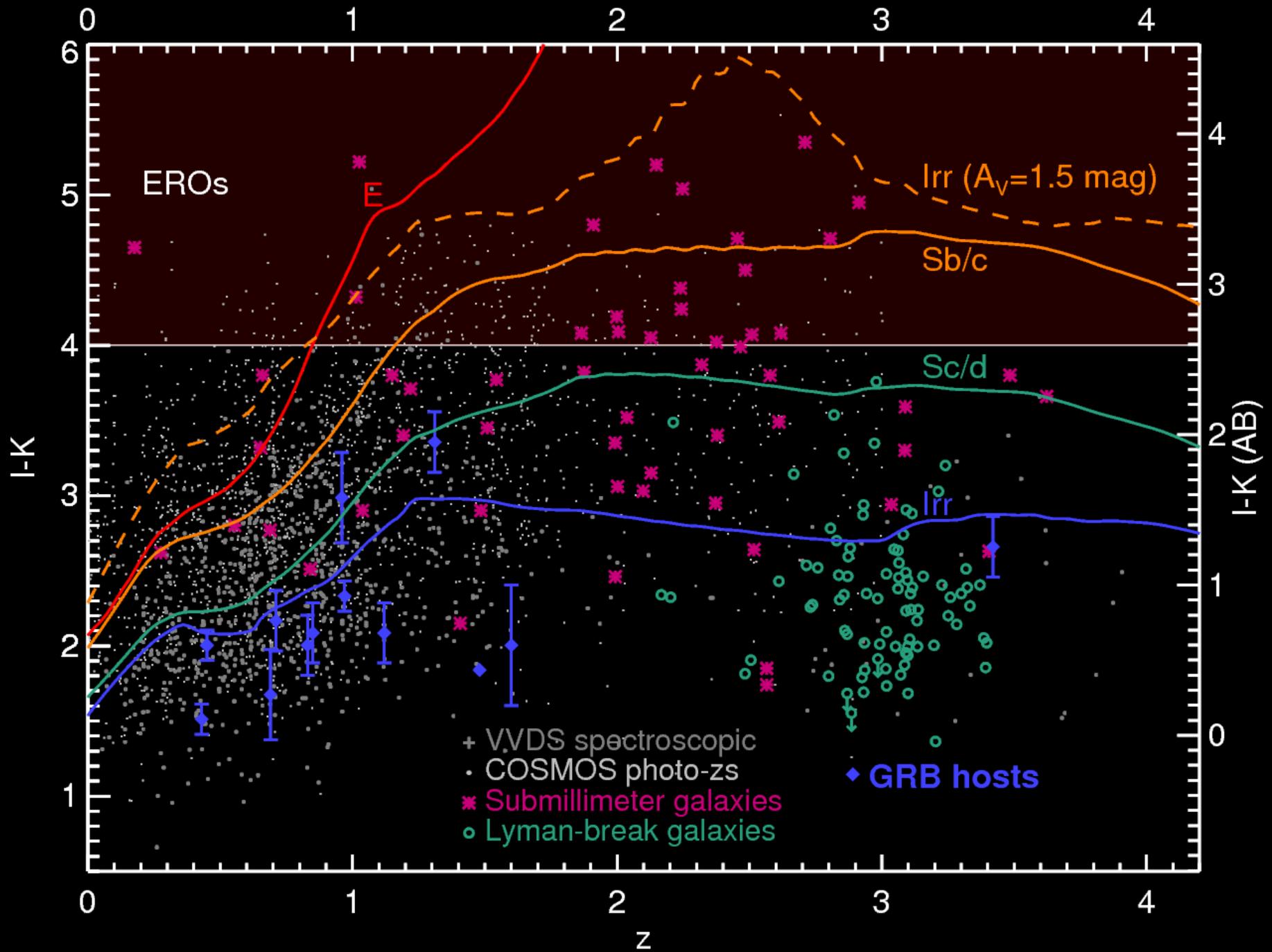


Ordinary GRB host SEDs

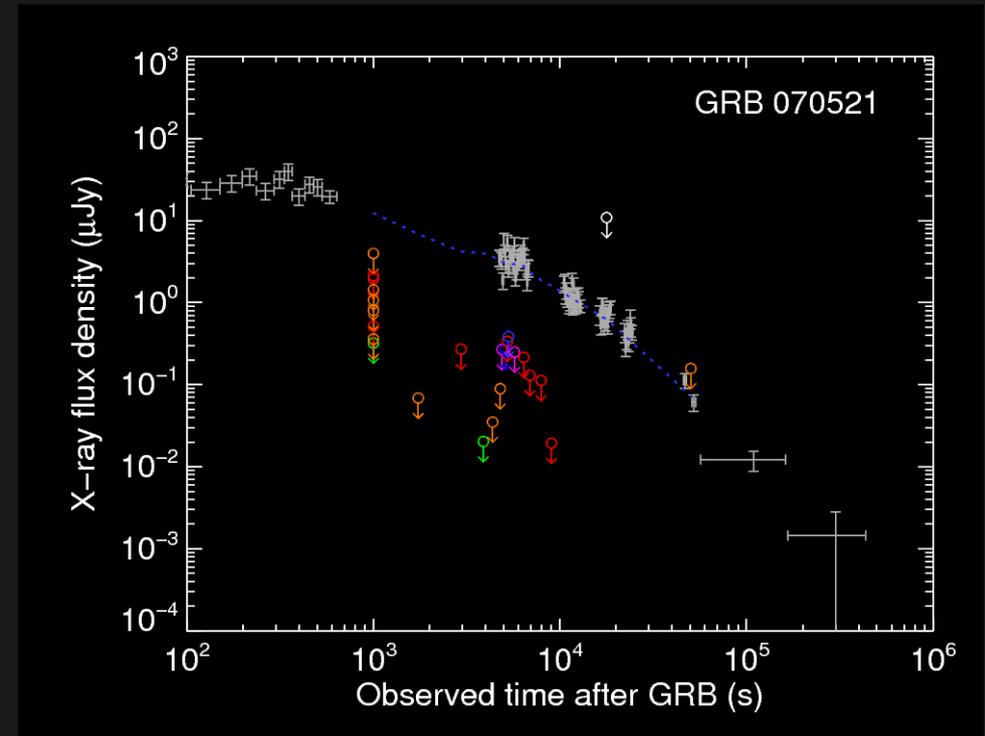
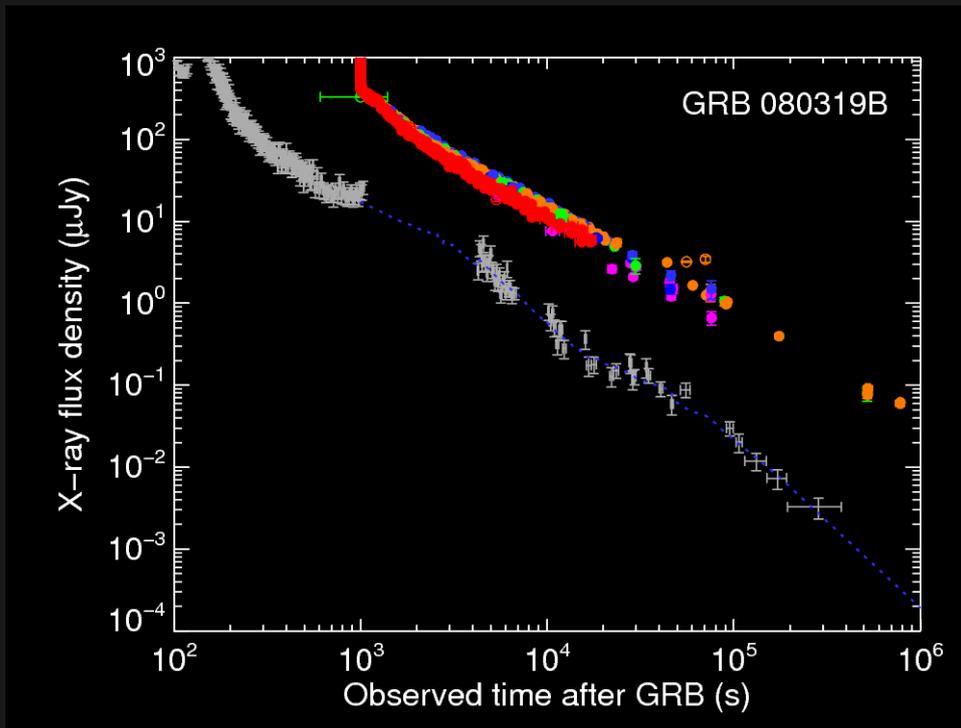
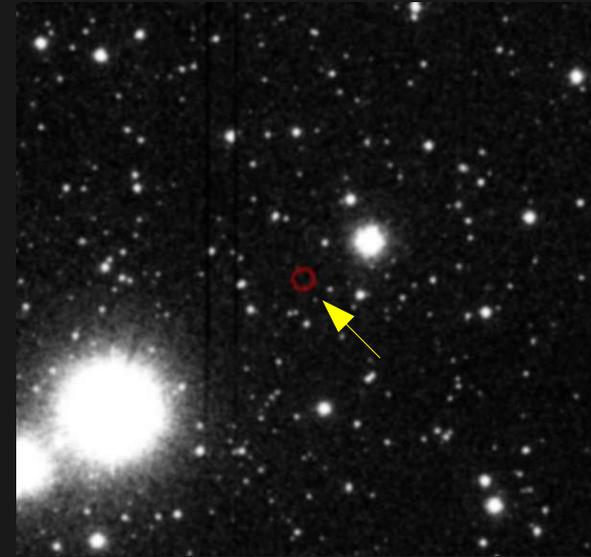
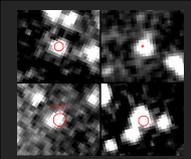


Pre-Swift SED data points from grbhosts.org

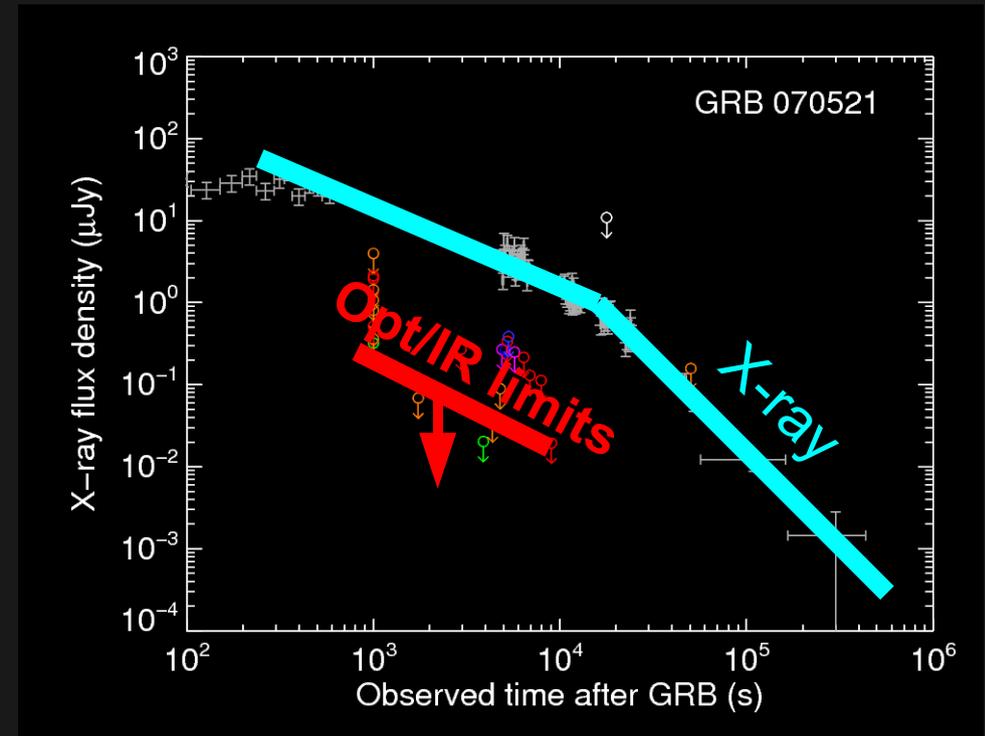
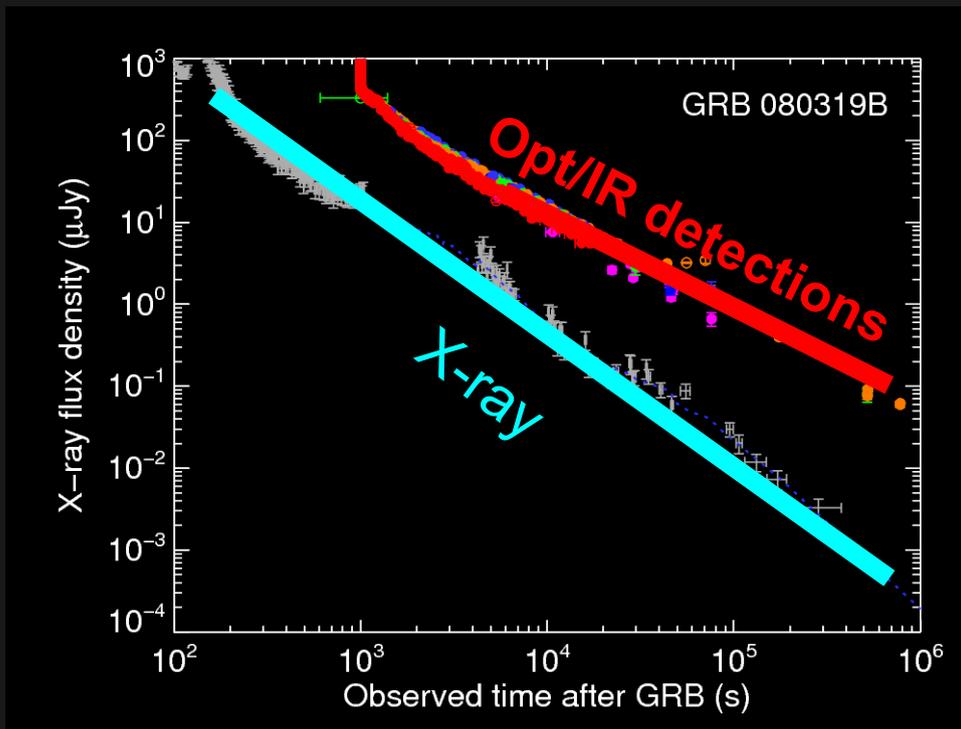
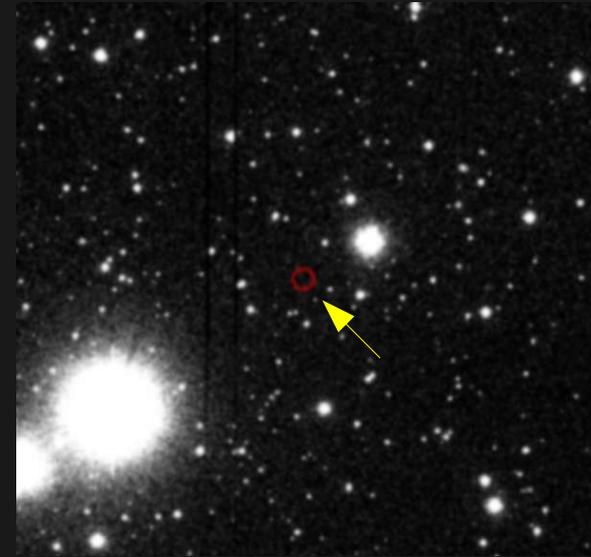
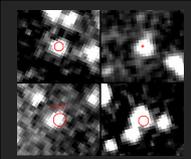
GRB Host Colors

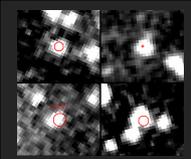


Dark Bursts

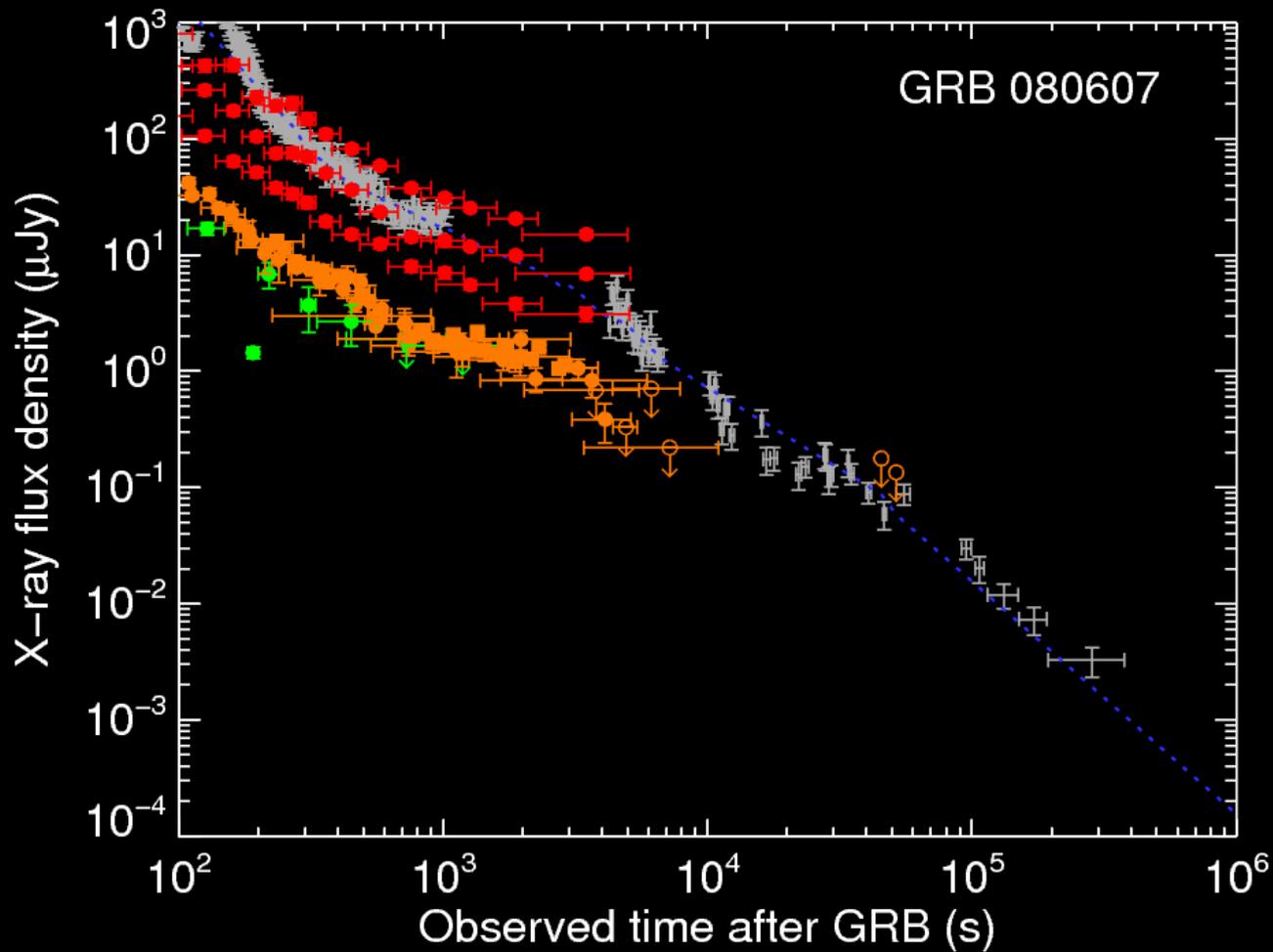


Dark Bursts

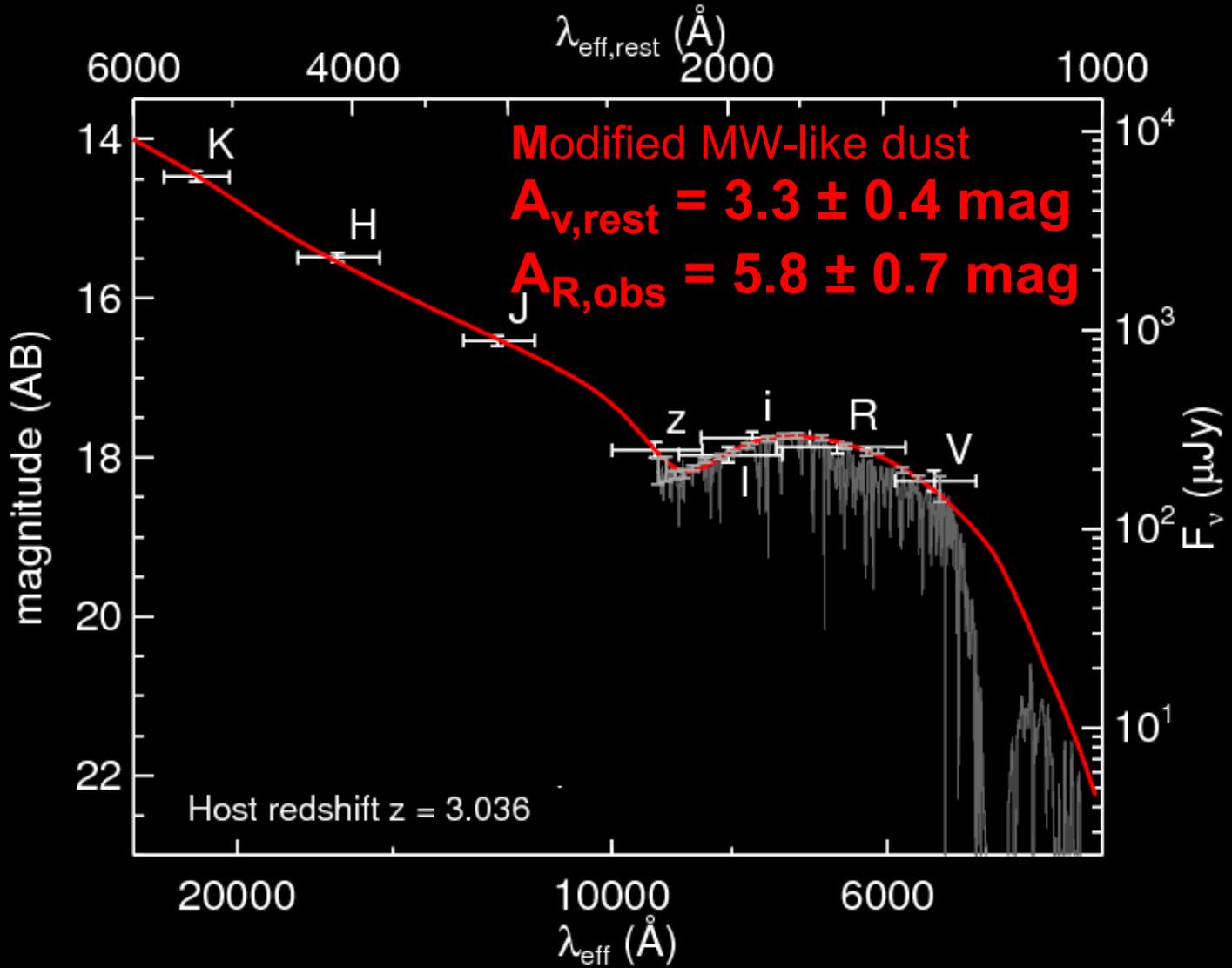
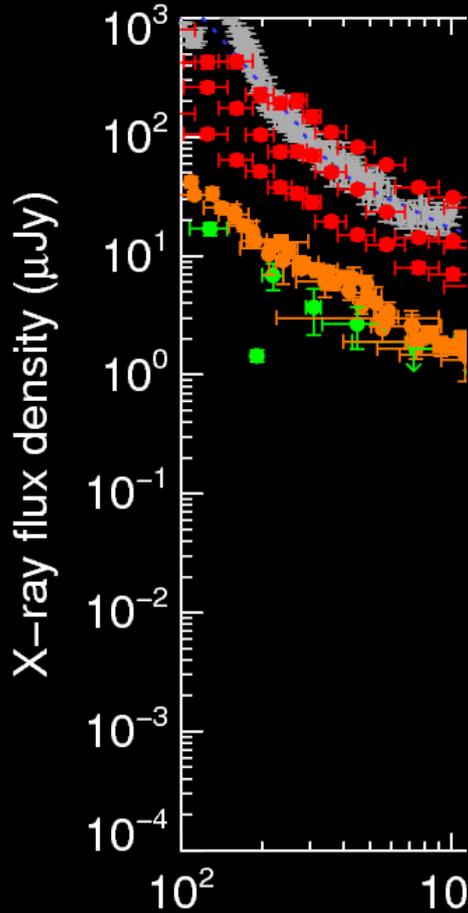
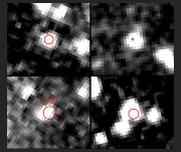




Dark Bursts are Dust-Reddened

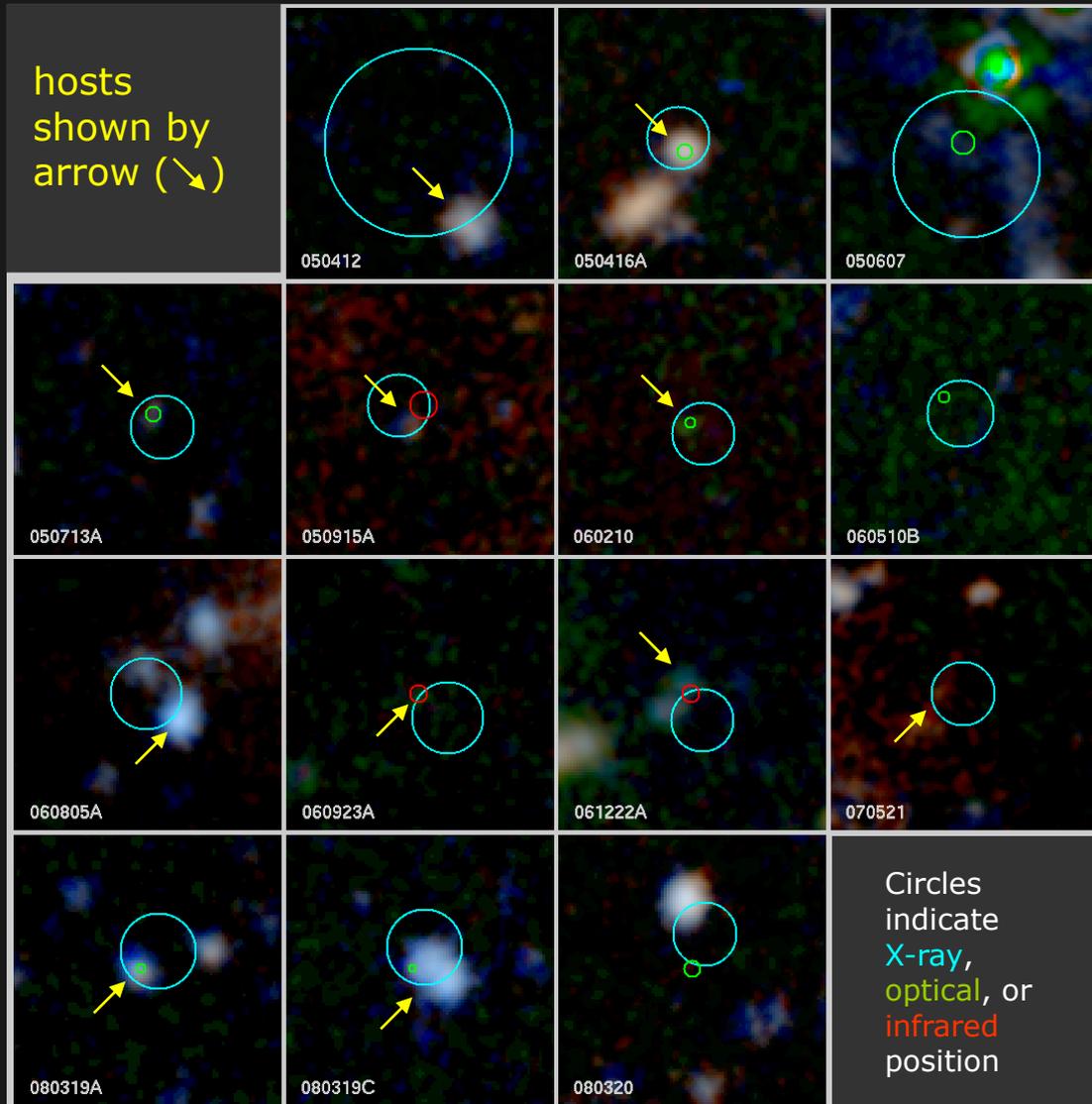
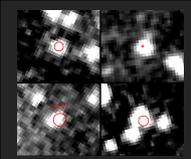


Dark Bursts are Dust-Reddened



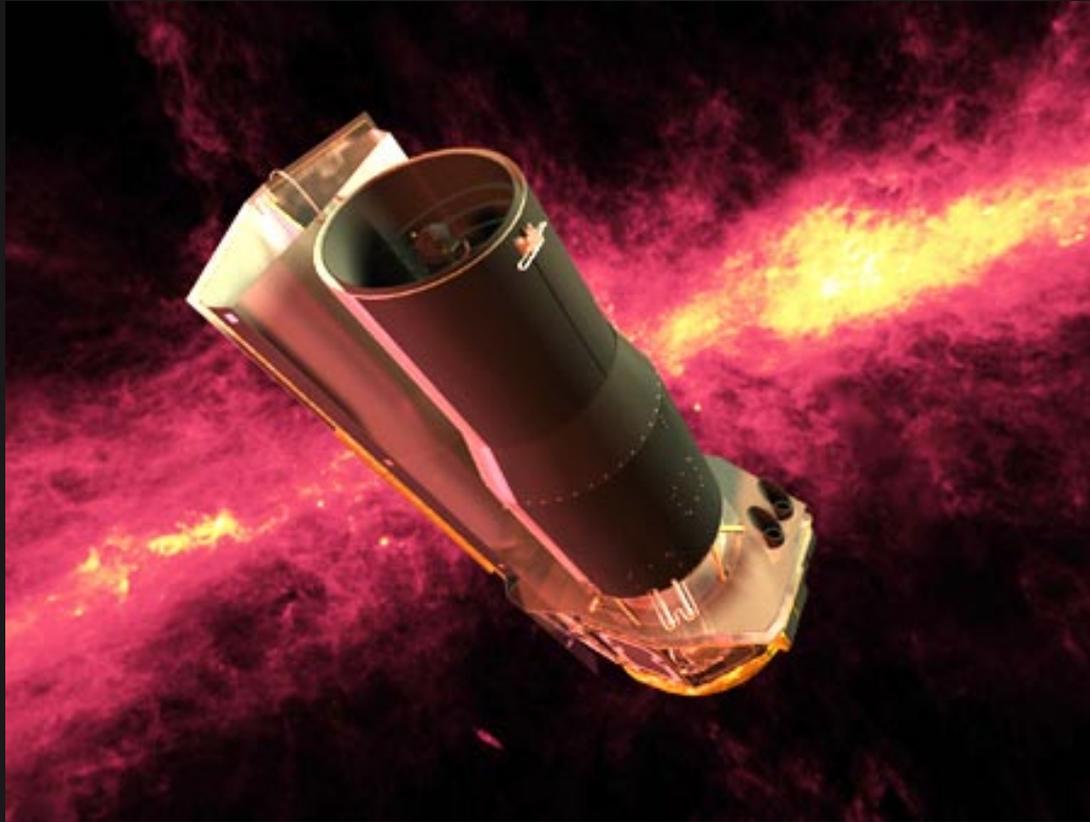
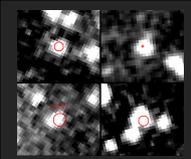
Perley et al. 2010

Dark Bursts are Dust-Reddened

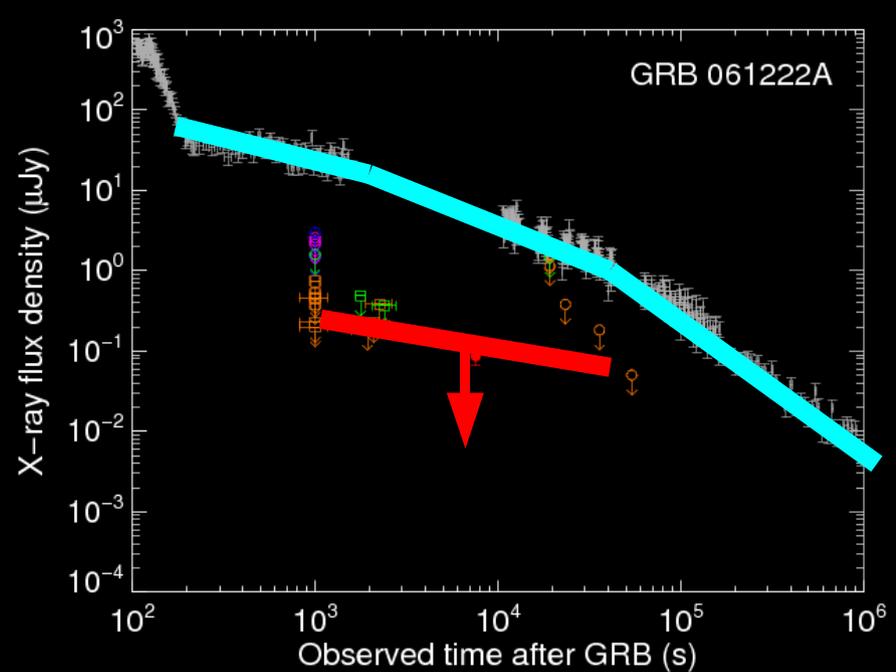
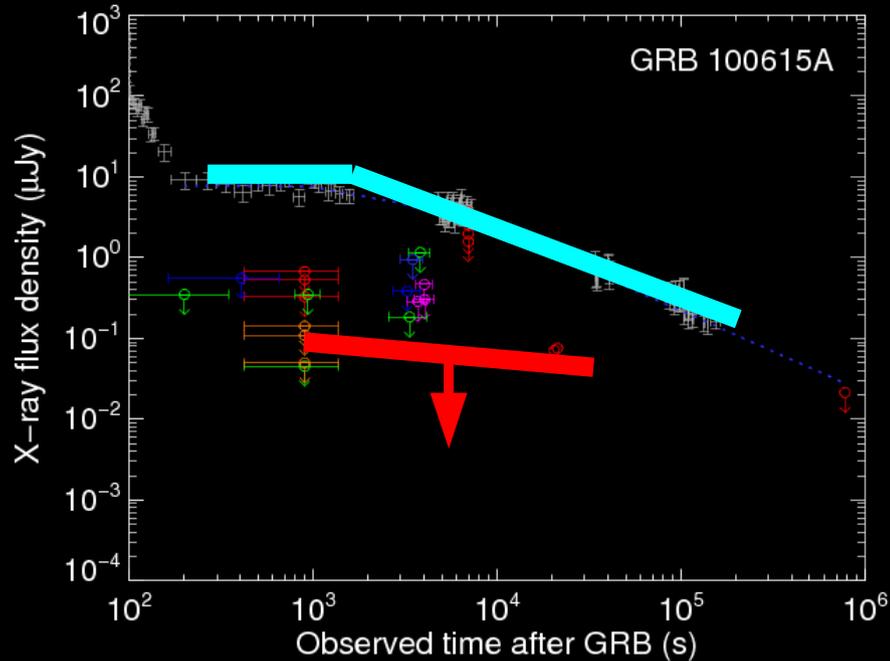
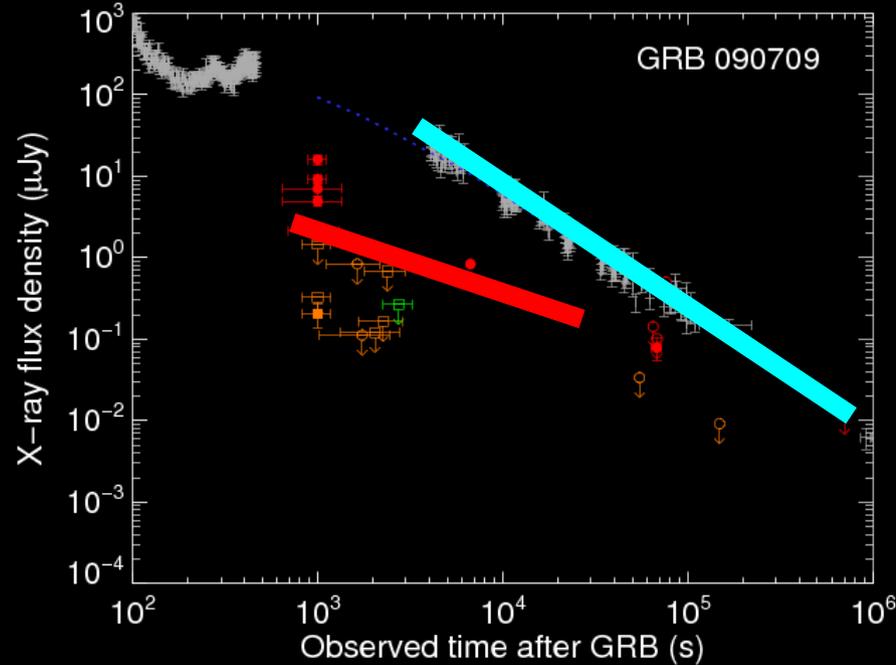
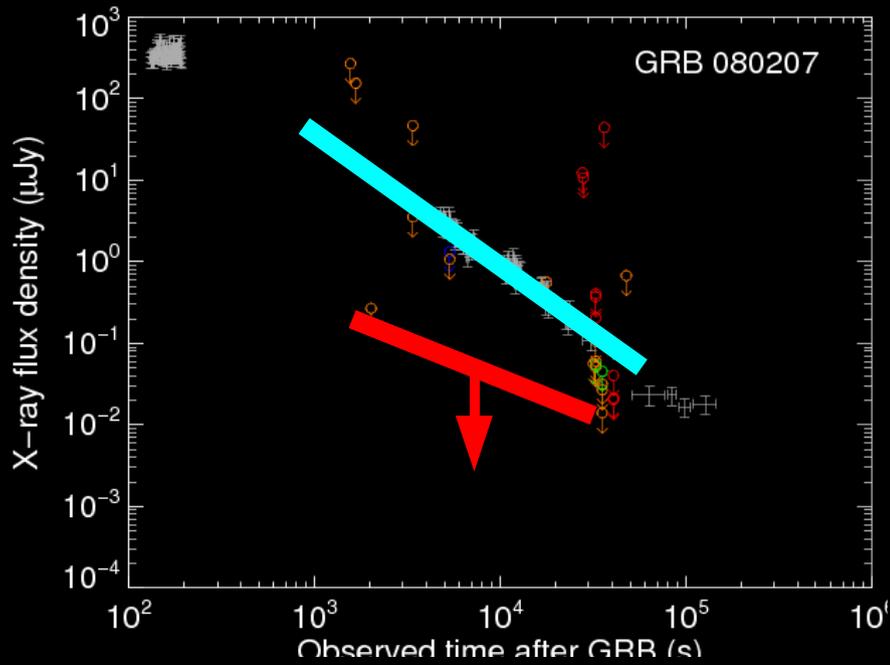
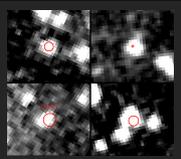


Perley et al. 2009

Dark Burst Host Survey

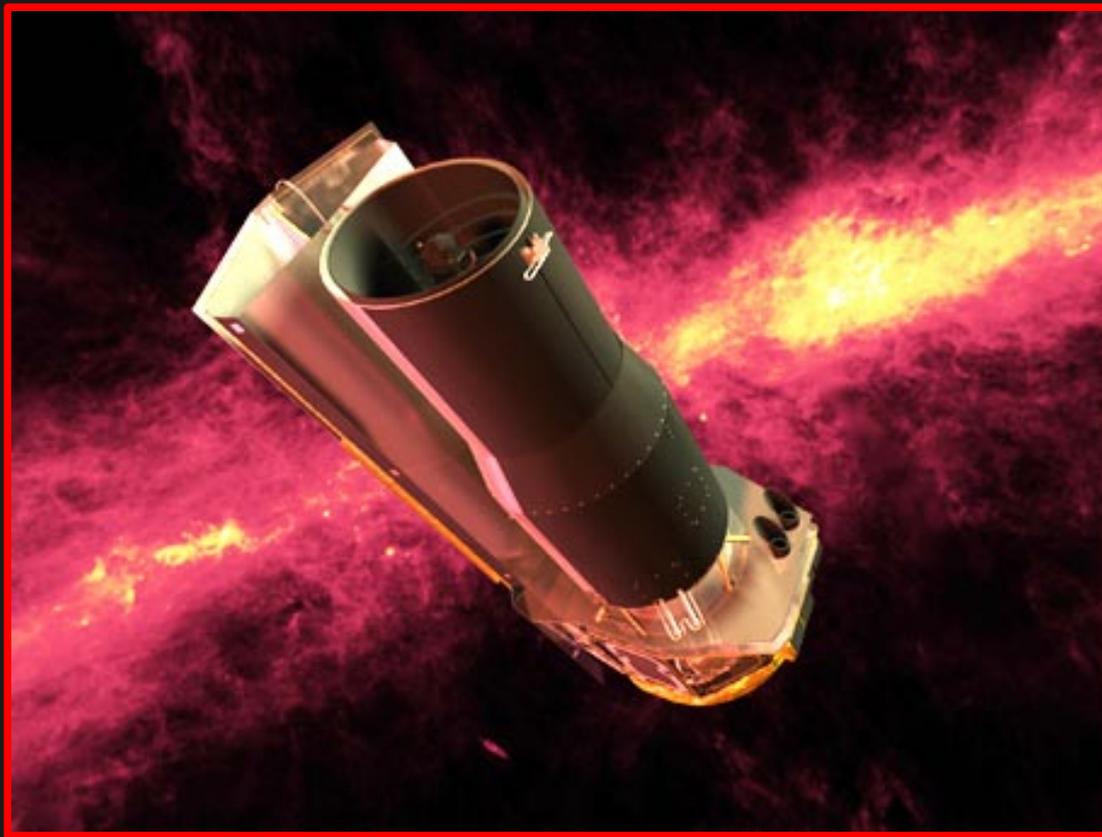
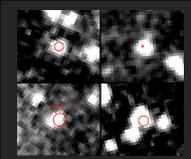


Dark Burst Host Targets

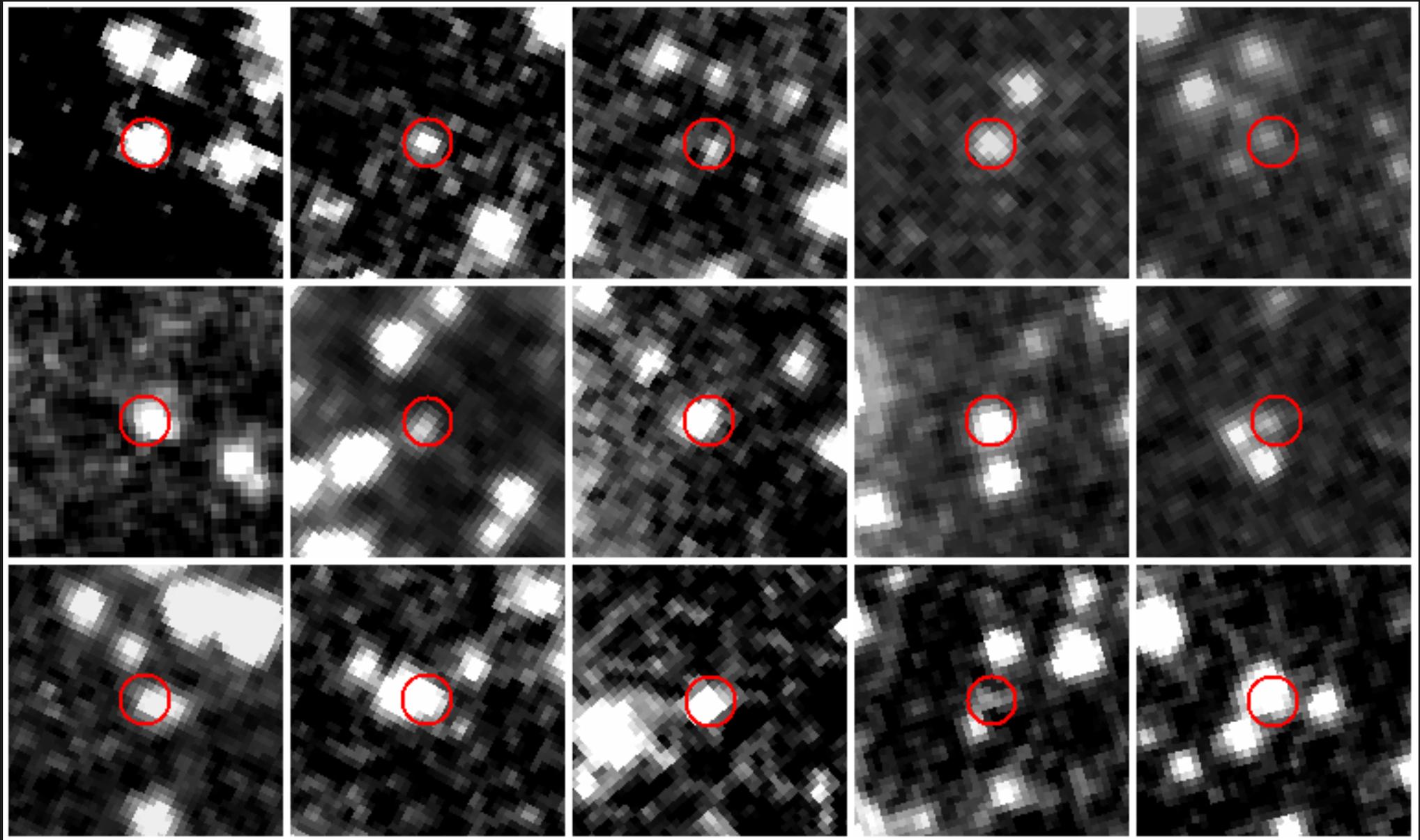


+20 more like this

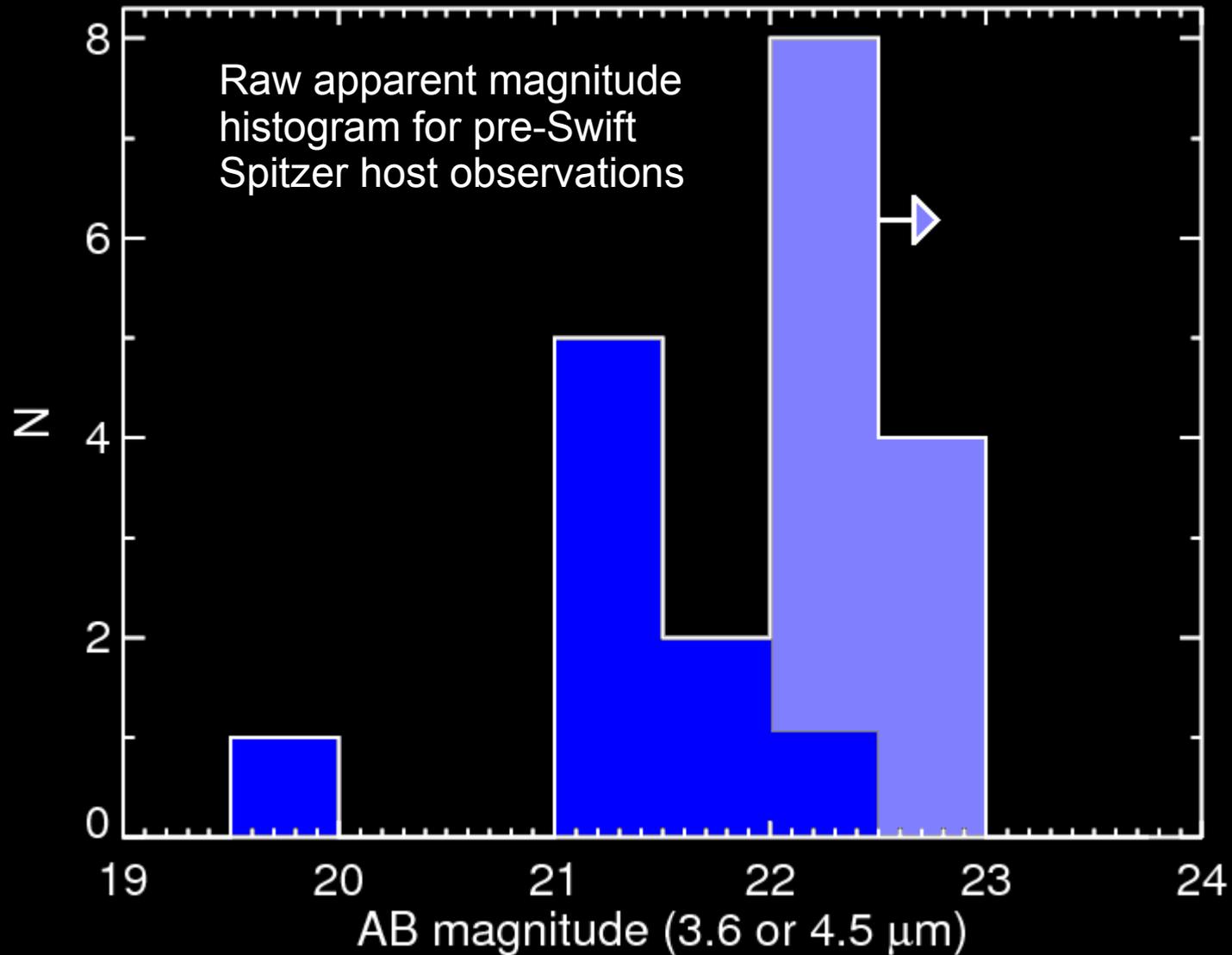
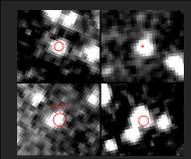
Dark Burst Host Survey



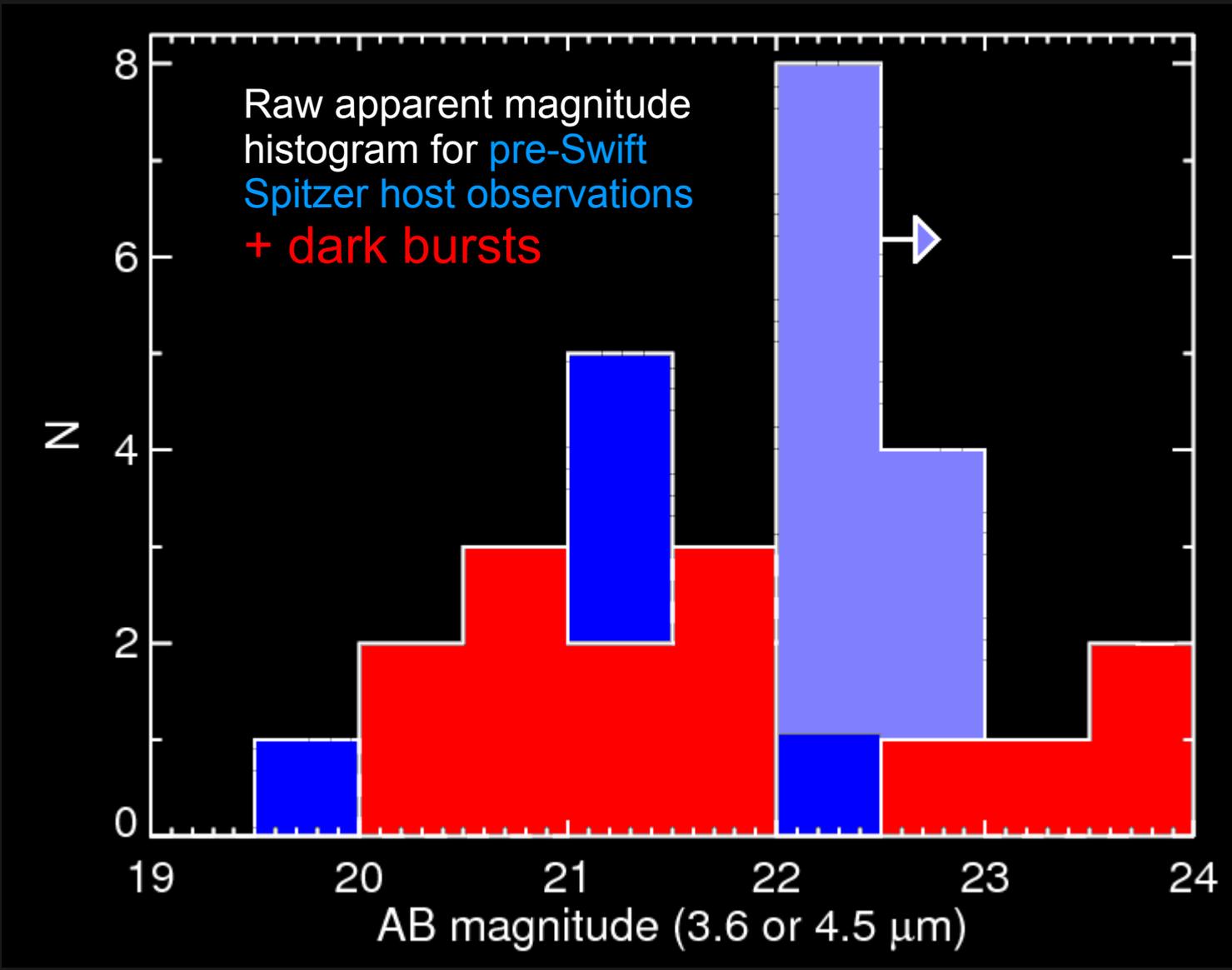
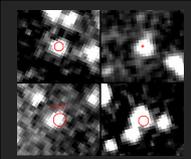
Spitzer Observations

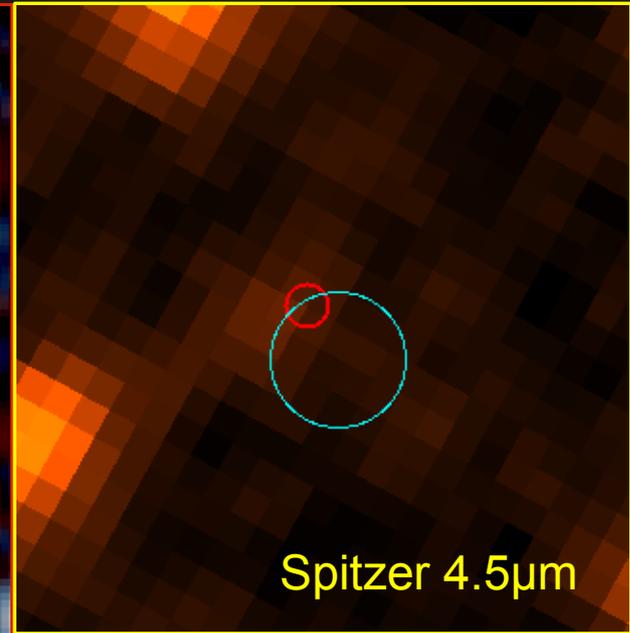
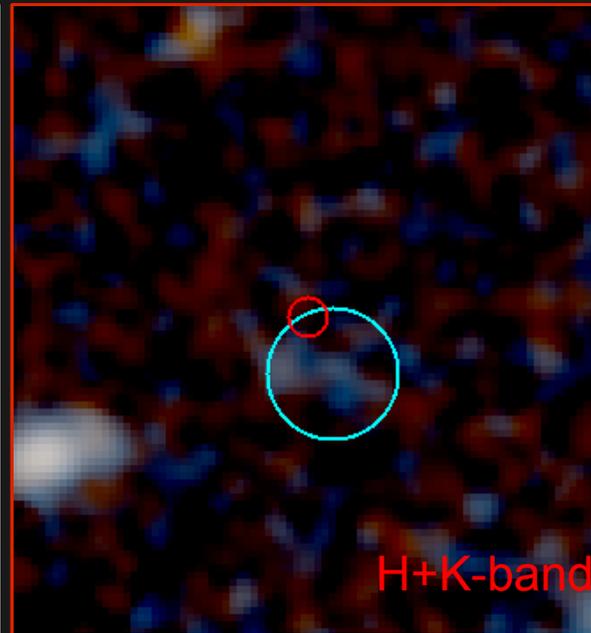
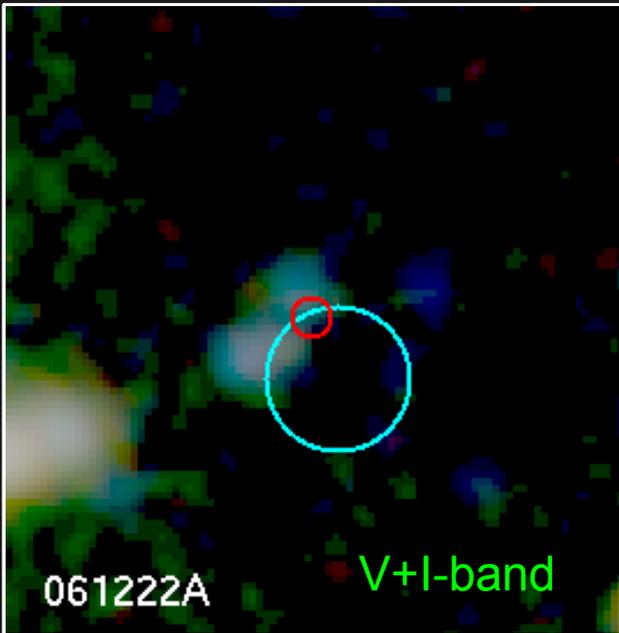


Spitzer Detections

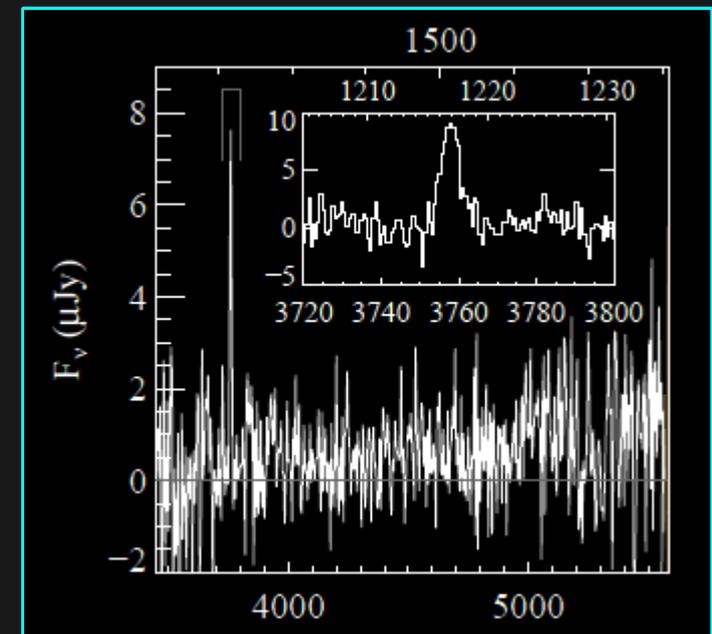


Spitzer Detections

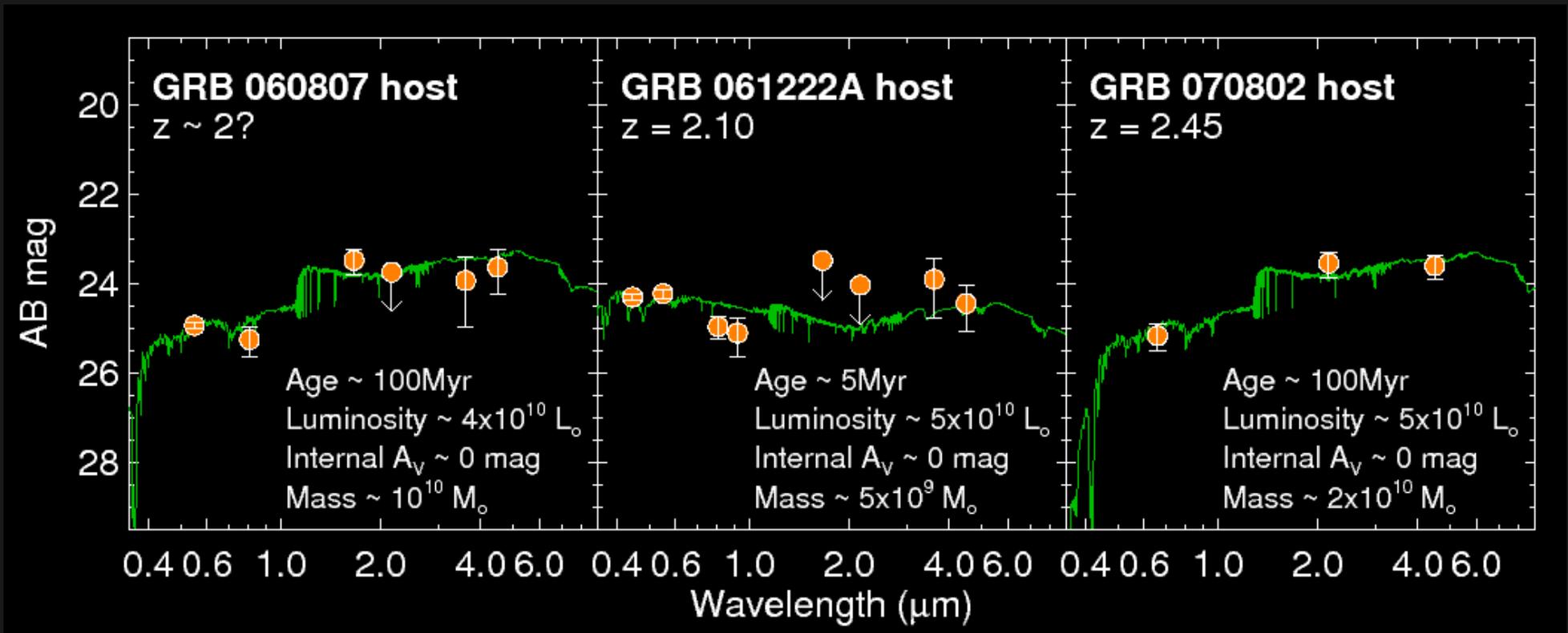
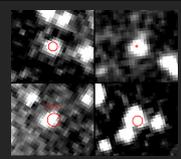




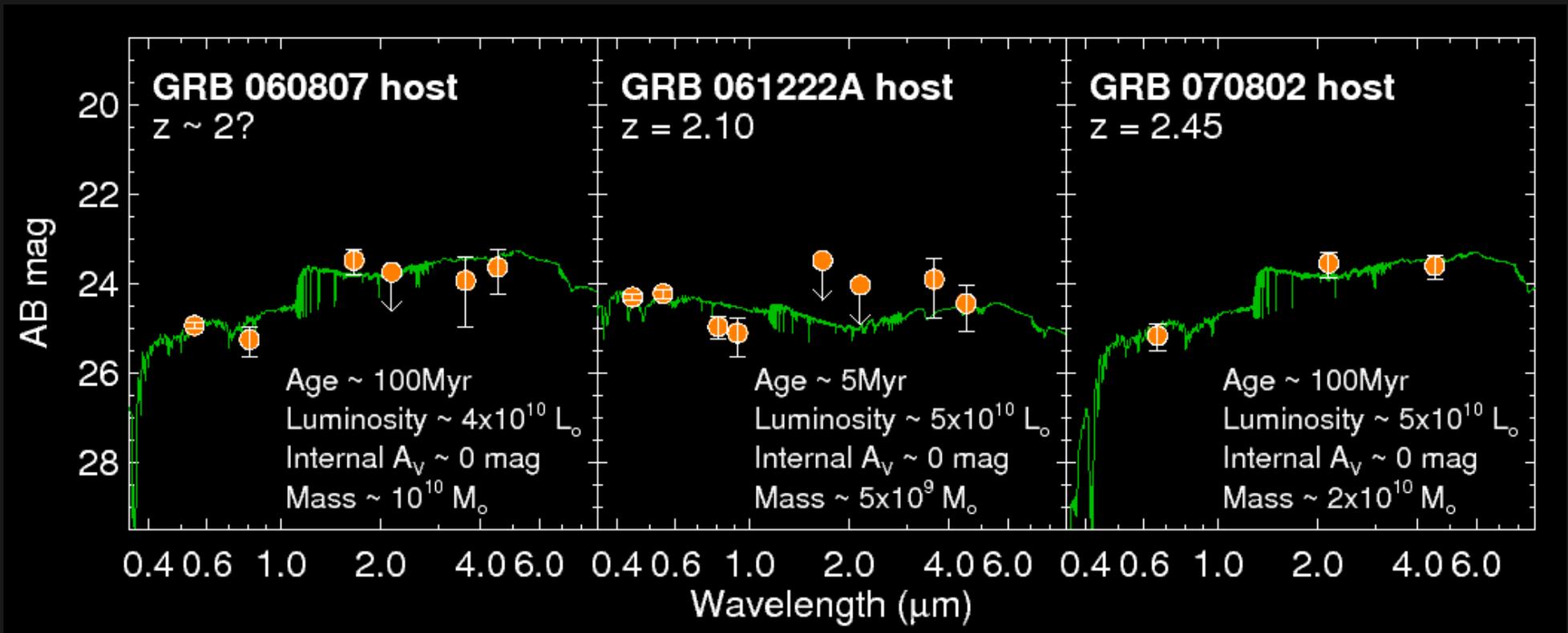
Ultra-dark burst ($A_V > 5$ mag), but
Extremely blue host:
 I-K ~ 2 mag
 marginal or no Spitzer detection
 Ly- α emitter at $z=2.1$



Blue Dark Burst Host Galaxies

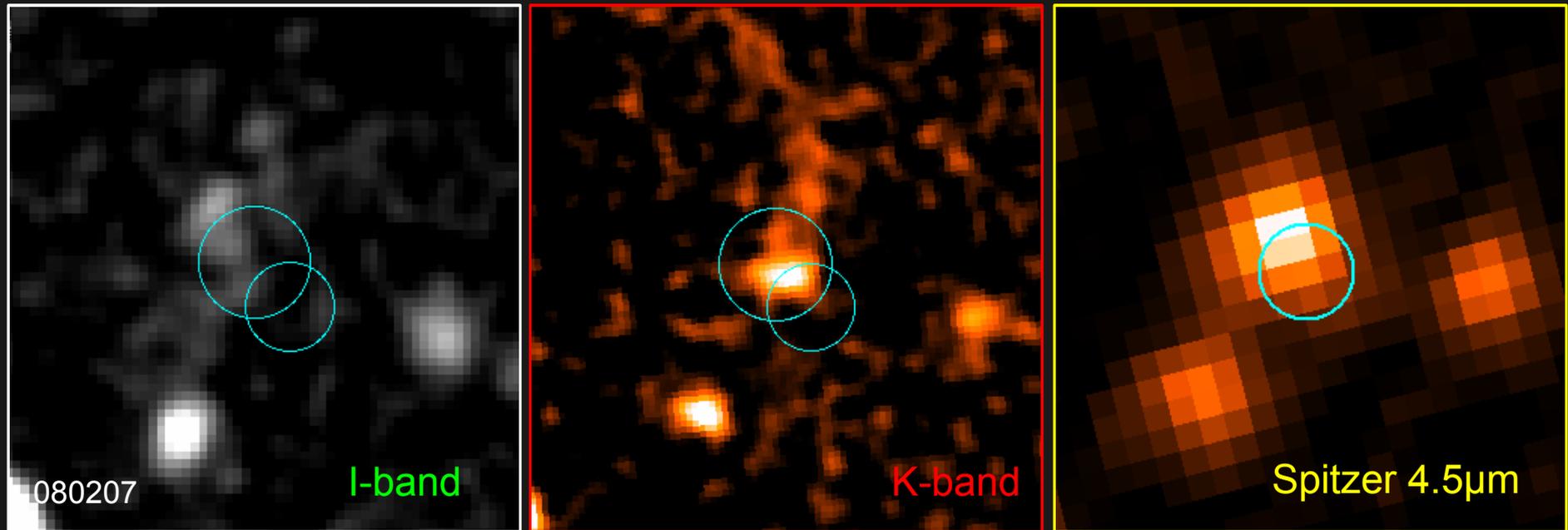


Blue Dark Burst Host Galaxies



“Where's the dust?”

Localized near the progenitor? (Destroyed if too close...)
Extremely heterogeneous ISM?



Fairly dark burst with...

Extremely red host:

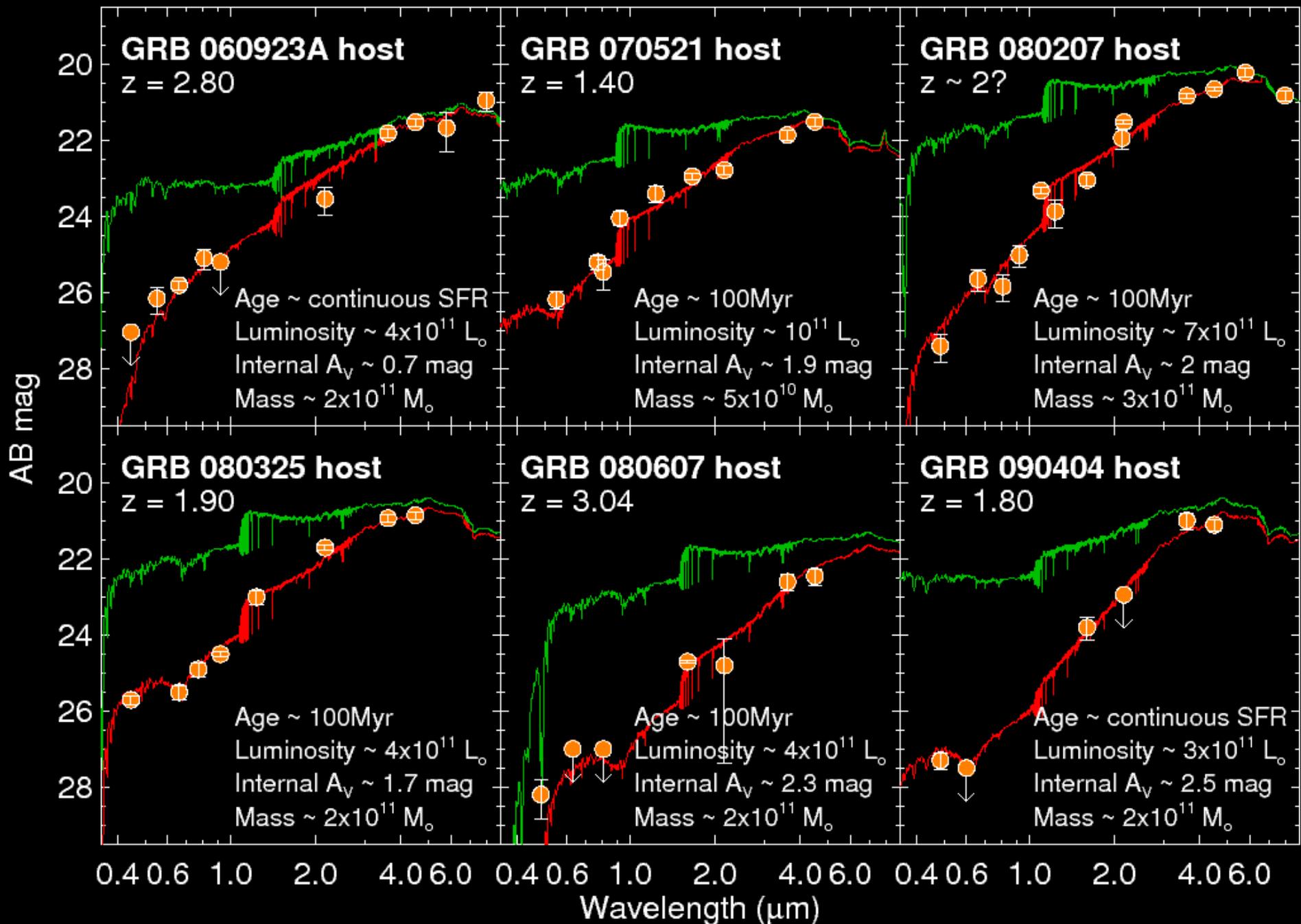
I-K ~ 5.5 mag

In top ~5% of brightest hosts observed by Spitzer,
also detected at 24 μ m with MIPS

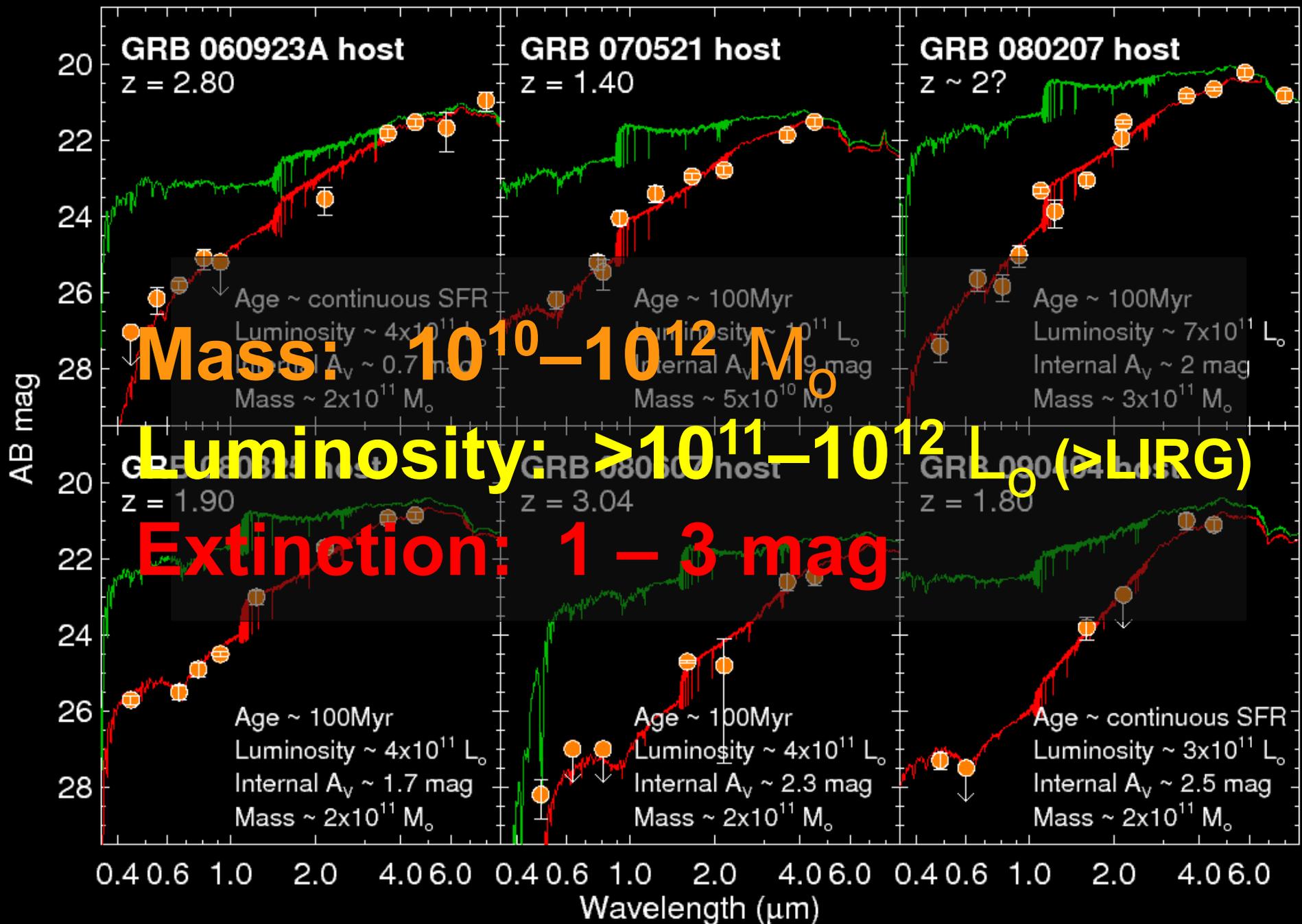
Optically faint, z unknown

(photo-z~2.1 from Svensson et al. in prep)

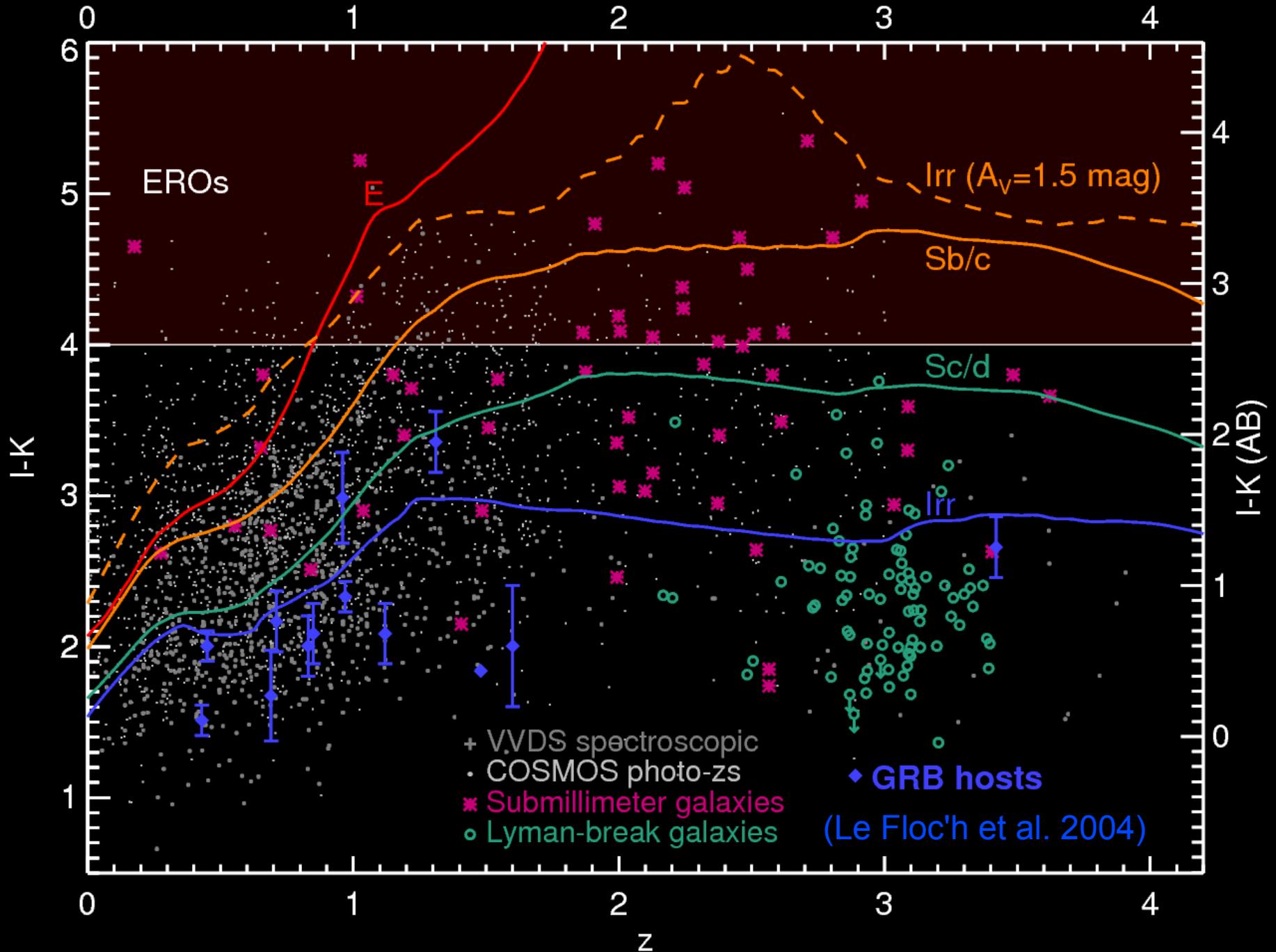
Red Dark Burst Host Galaxies



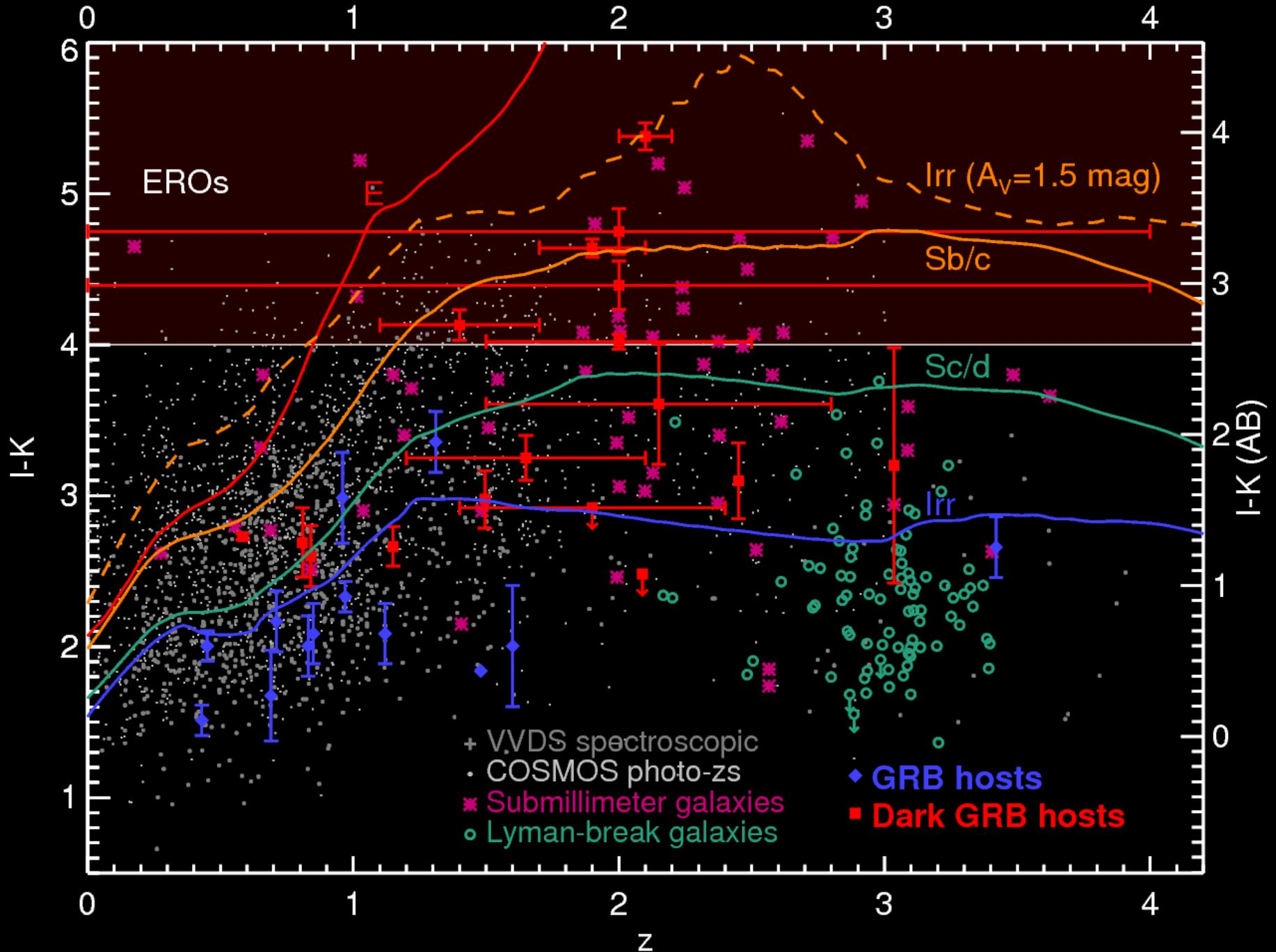
Red Dark Burst Host Galaxies



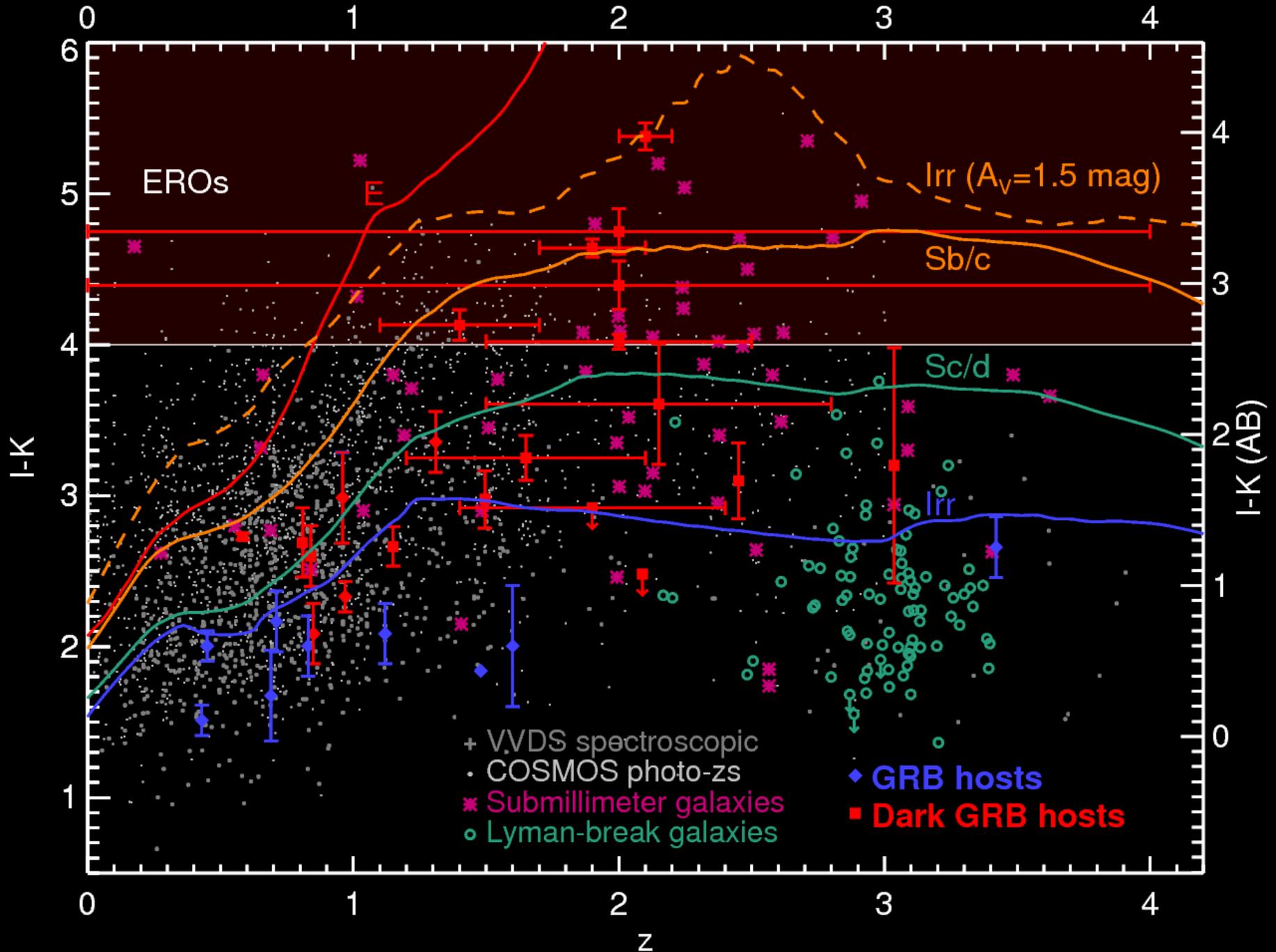
Dark Burst Host Colors



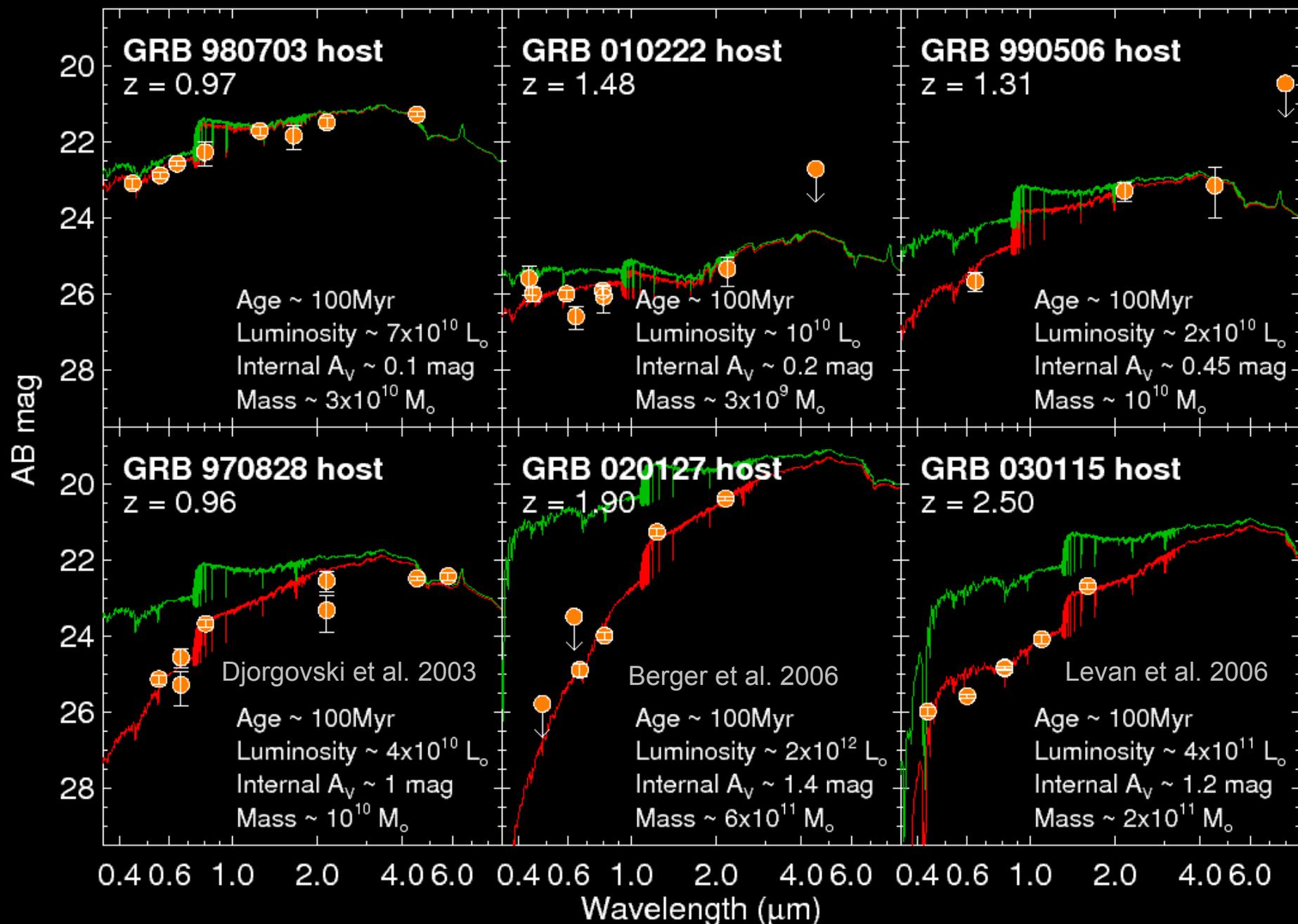
Dark Burst Host Colors



Dark Burst Host Colors



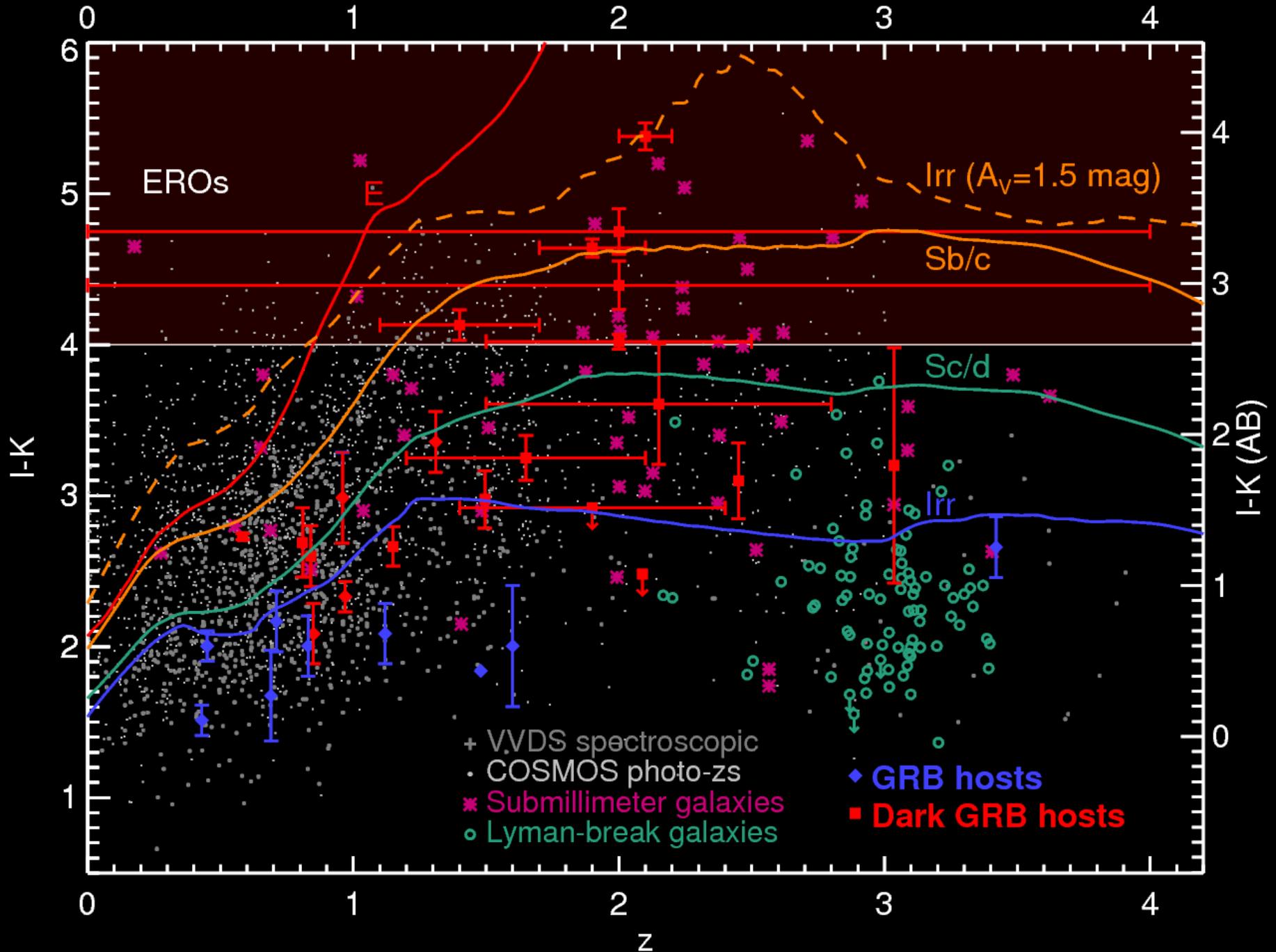
Pre-Swift Red Dark Burst Hosts



Dusty GRB → Dusty host galaxy
(sometimes)

Dust-free GRB → Dust-free host galaxy
(always?)

Dark Burst Host Colors



Dusty GRB → Dusty host galaxy
(sometimes)

Dust-free GRB → Dust-free host galaxy
(always?)

In most cases, dust seen along a burst sightline is also seen along sightlines to other stars:

not local to progenitor or too heterogeneous
(prominent exceptions exist!)

GRBs *can* form in most or all types of star-forming galaxies (LIRGs, ULIRGs)

→ No metallicity limit?

→ Uniform star-formation tracer after all?

GRBs *can* form in most or all types of star-forming galaxies (LIRGs, ULIRGs)

→ No metallicity limit?

Not actually measured for most targets – but:

Dark $z=3$ GRB 080607 afterglow spectrum: $Z \sim$ solar

Levesque study of GRB 020819: $Z >$ solar

Soderberg relativistic SN 2009bb: $Z >$ solar

Graham study of GRB 051022: $Z \sim$ solar (poster)

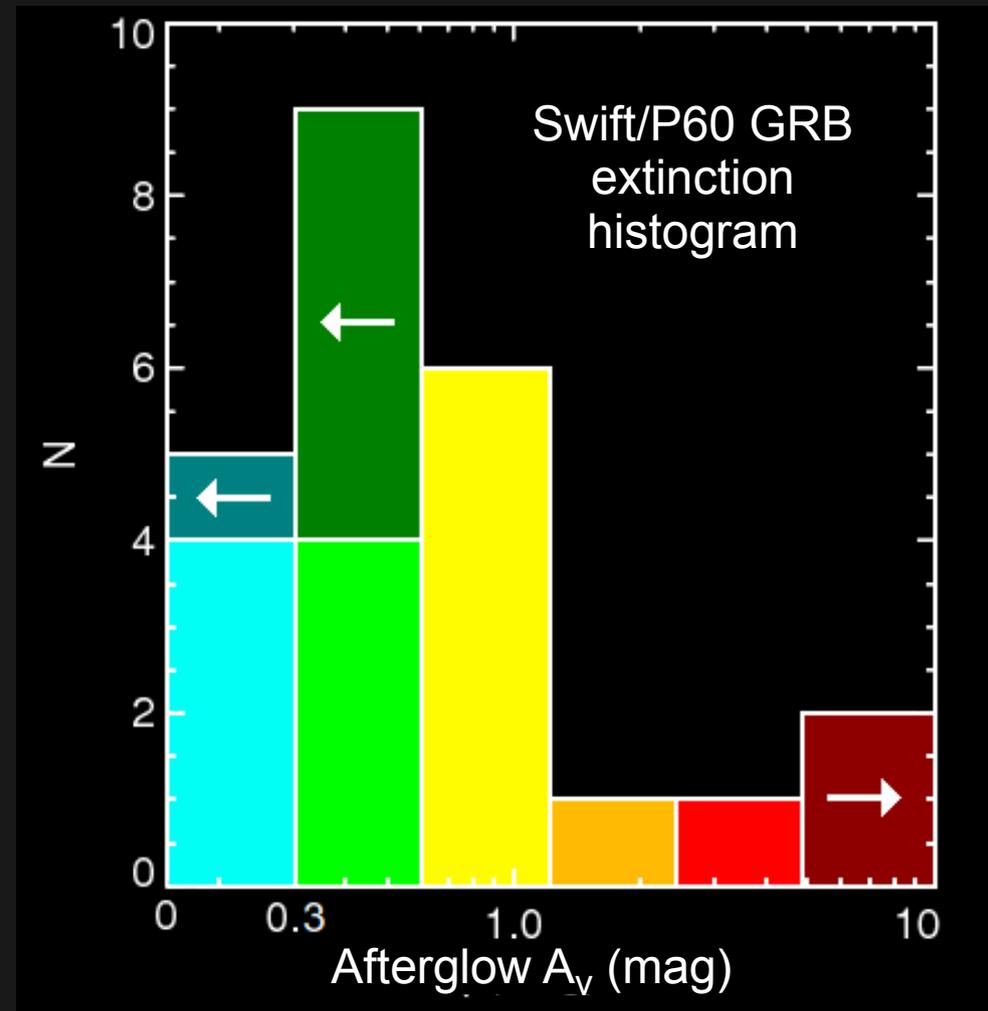
Mean metallicity at $z \sim 2$ is lower

(see posters by Kocevski, Laskar)

→ Uniform star-formation tracer after all?

GRBs trace star formation after all?

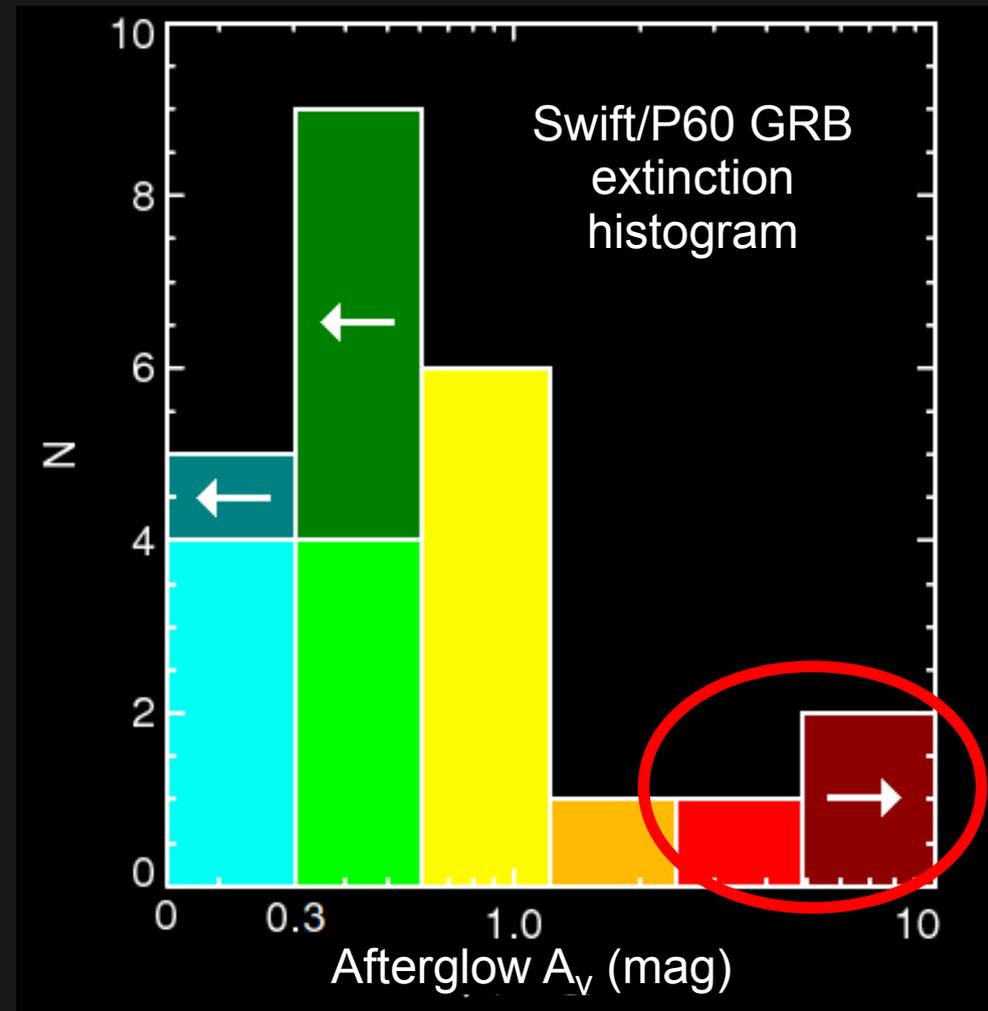
Perley et al. 2009
(also, Greiner et al. 2010,
Nardini talk Tuesday)



GRBs trace star formation after all?

very dark bursts are
~20% of all GRBs

Perley et al. 2009
 (also, Greiner et al. 2010,
 Nardini talk Tuesday)



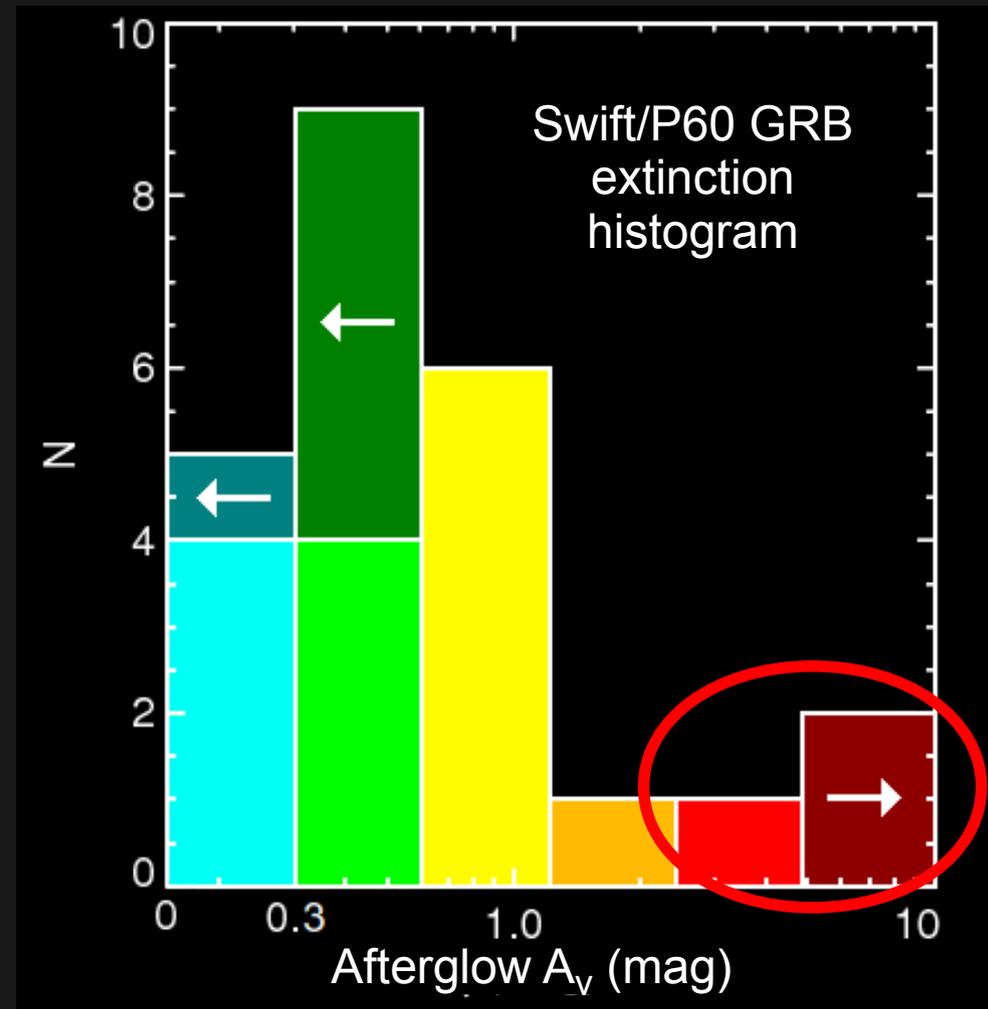
GRBs trace star formation after all?

ERO-type hosts are
~50% of very dark GRBs,
 which in turn are **~20%** of all GRBs:

only **~10%** of hosts
 are like this
 (LIRG/ULIRG)

very few EROs in uniform sample of
 Jakobsson (this session)

Perley et al. 2009
 (also, Greiner et al. 2010,
 Nardini talk Tuesday)



GRB environments are more diverse than previously thought.

No metallicity cut (strict upper limit), but perhaps a metallicity preference?

Second channel for stripping the envelope without losing momentum (i.e., binary?)

When doing host studies, we must understand our selection biases!

Reddish Dark Burst Hosts

